

On the syllable structure effect in European Portuguese: Evidence from ERPs

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ABSTRACT

Syllable effects during visual word recognition have been observed for CV but not for CVC syllables, a puzzling effect that is not explained either by the distributional frequencies of CV and CVC syllables, syllable complexity, or syllabic neighbourhood density. Furthermore, in European Portuguese (EP), syllable effects have not been found for pseudowords, suggesting that syllable activation might not precede lexical activation. Here, we combined a colour-congruency lexical decision task with the collection of electroencephalographic (EEG) data to investigate syllable effects in EP for CV and CVC words and pseudowords, with the latter presenting a match (CVC_{O+P+}) or a mismatch (CVC_{O+P-}) between their orthographic (O) and phonological (P) syllable structure to further ascertain the locus (i.e., orthographic and/or phonological) of syllable effects. Results showed syllable congruency effects in the N100, P200, and N400 ERP components for CV and CVC words suggesting the influence of different factors underlying the syllable structure effect.

1. Introduction

Although much evidence has been gathered in the last decades concerning the role of the syllable as a sublexical unit during visual word recognition in studies conducted in different languages and using different tasks and paradigms (e.g., lexical decision: Álvarez et al., 1998, 2000, 2001; Carreiras et al., 1993; Conrad et al., 2006, 2007, 2008; Conrad & Jacobs, 2004; Kwon et al., 2011; Perea & Carreiras, 1998; Stenneken et al., 2007; naming: Carreiras et al., 1993; Chetail & Mathey, 2009; Stenneken et al., 2007; masked priming lexical decision studies: Álvarez et al., 2004; Campos et al., 2018, 2020, 2021; Carreiras & Perea, 2002; Chetail & Mathey, 2009; Mathey et al., 2013; illusory conjunction: Katz & Baldasare, 1983; Seidenberg, 1987), several questions remain unclear. One of the most overlooked issues is why syllable effects observed in masked priming lexical decision studies emerge for words with a CV (C stands for consonant and V for vowel) first-syllable structure (e.g., ru.mour), but not for words with a CVC first-syllable structure (e.g., car.bon) – note that the dots are only used in the examples to ease comprehension and not in the stimuli presented to participants in the above-mentioned studies. Another relevant issue concerns the extent to which syllable effects are supported by lexical and/or sublexical

representations since several studies conducted in different languages have yielded mixed results. Whilst some have shown syllable effects with pseudowords (e.g., Álvarez et al., 2000; Carreiras et al., 1993), others have failed to show such effects (e.g., Campos et al., 2018, 2021; Ferrand & New, 2003; Muncer & Knight, 2012). Moreover, the nature (orthographic and/or phonological) of the representations in which syllable effects rely on, and if these might change as a function of the stage of visual word recognition (earlier vs. later stage), task requirements, and the characteristics of the language in use, are also open questions in psycholinguistic literature.

The advantage of CV over CVC syllables in masked priming lexical decision studies, the so-called *syllable structure effect*, was first observed by Álvarez et al. (2004) in a seminal study conducted with Spanish skilled readers to test whether syllable effects occurred at early stages of visual word recognition while controlling for the orthographic overlap between primes and targets. Specifically, in that study, the authors presented participants with disyllabic Spanish words beginning either with a CV (e.g., JU.NIO [june]) or a CVC first-syllable structure (e.g., MON.JA [nun]), which were preceded by briefly-presented (64 ms) pseudoword primes that could share the first three letters and the first syllable with the target (e.g., ju.nas-JU.NIO; mon.di-MON.JA), or the

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first three letters but not the first syllable with the target (e.g., *jun.tu-JU.NIO*; *mo.nis-MON.JA*), giving rise to the syllable-congruent and the syllable-incongruent conditions, respectively. Results showed that participants were faster at recognizing words preceded by syllable-congruent than syllable-incongruent primes, though, unexpectedly, only for CV words (*ju.nas-JU.NIO* < *jun.tu-JU.NIO* but *mon.di-MON.JA* = *mo.nis-MON.JA*).

This result, which casts doubts about the role that syllables play as units for lexical access (see Taft & Álvarez, 2014, for a discussion), was explained by Álvarez et al. (2004) based on a syllable frequency account, i.e., the fact that CV is the most common syllable structure in the Spanish language (it is estimated to occur three times more than the CVC syllable structure – see Álvarez et al., 2004 for details), which might cause the parser to syllabify words by using a CV syllable structure by default. This explanation was also advanced by Chetail and Mathey (2009) in a similar study conducted with French skilled readers where the syllable structure effect was also observed. However, this proposal was recently challenged by Campos et al. (2018) in a masked priming lexical decision study conducted with skilled readers of European Portuguese (EP), a language where the difference between the number of CV and CVC syllables is much less pronounced than in the Spanish or French languages (according to the ProcuraPALavras lexical database - P-PAL; Soares et al., 2014, 2018, 38% of the EP words present a CV first-syllable structure whilst 30.2% present a CVC first-syllable structure), but where syllable priming effects were still only observed for CV words.

In an attempt to ascertain the factors that might underlie the syllable structure effect observed in EP and, possibly, in other languages, Campos et al. (2020) tested whether syllable complexity could account for that result by increasing prime durations from 50 ms (as used in Campos et al.'s 2018 work) to 67 ms and 82 ms. The rationale behind that manipulation was that since CVC syllables are more complex than CV syllables (note that CVC syllables not only entail an additional syllable component, the coda, but also a component that has been proven to be the hardest to process - see Content et al., 2001; Treiman & Danis, 1988), it would be possible that CVC syllables might require more time to be activated, hence explaining the syllable structure effect. Yet, the results showed that even with increased prime durations, reliable syllable effects in EP were only observed for CV words, ruling out syllable complexity as a plausible explanation.

Nevertheless, Campos et al. (2020) put forward an alternative account. Even though the stimuli used in their study, and in the study of Campos et al. (2018), had been controlled for in a broad range of psycholinguistic variables known to affect word processing, including the number of times CV and CVC words occurred in the EP language (token syllable frequency), a post-analysis revealed that CV words presented a higher number of syllable neighbours i.e., the number of words with the same syllable length sharing the first syllable in the same (first) position as the target, the analogous of the Coltheart's *N* orthographic neighbourhood density measure to the syllable domain, when compared to CVC words (type syllable frequency), which might explain the results. Specifically, because the CV words in Campos et al.'s (2018, 2020) studies presented a higher type frequency, a measure that can be also taken as an index of syllabic neighbourhood density, than the CVC words, this might have speeded up the recognition for CV words, similarly to what occurs with orthographic neighbours in visual word recognition (for a review see Perea et al., 2015). Thus, upon the presentation of a syllable-congruent pseudoword prime (e.g., *rumis-RUMOUR*), it is possible the letter string would be syllabified as *ru.mis*, and the first syllable would send activation to all the words with the same syllable length, sharing the same syllable < ru > at the first position (e.g., *rua* [street], *rubi* [ruby], *rubor* [blush], *rubro* [red], *rudez* [rudeness], *rumor* [rumour]). Because CV words tend to come from larger syllabic neighbourhoods than CVC words, the higher level of activation generated by the presentation of CV rather than CVC pseudoword primes would decrease the time needed to produce a "yes" response, hence explaining the syllable structure effect. This account

agrees with the with the "fast-guess" mechanism proposed within the Multiple Read-Out Model (MROM; Grainger & Jacobs, 1996) and its recent extension (MROM-S; Conrad et al., 2010), which implemented a syllabic layer between the letter level and the word level of processing to account for the syllable frequency effect observed in the Spanish language. Note that in studies manipulating syllable frequency (e.g., Álvarez et al., 1998, 2000, 2001; Carreiras et al., 1993; Carreiras & Perea, 2002; Conrad & Jacobs, 2004; Conrad et al., 2006, 2007, 2008; Kwon et al., 2011; Perea & Carreiras, 1998), words with high-frequency first syllables tend to take longer to be recognized. This syllable-frequency inhibitory effect has mostly been explained due to the greater number of lexical candidates that words with high-frequency first syllables activate, which would compete with the target word for activation, increasing the time needed for recognition to take place (see Conrad et al., 2010). In masked priming lexical decision studies manipulating syllable congruency, however, this would not be the case since the primes, being pseudowords, would not directly compete with the target for activation (see Carreiras & Perea, 2002 for details). Hence the activation of the syllable, through the prime presentation, would cause a facilitation effect, as it has been systematically observed in the literature (nonetheless see Mathey et al., 2013 for a detailed account of how pseudowords might, under certain cases, produce inhibition).

In order to directly test syllabic neighbourhood density as the driving force for the syllable structure effect, in a recent study conducted in EP Campos et al. (2021) replicated the same paradigm as in previous masked priming studies (e.g., Álvarez et al., 2004; Campos et al., 2018, 2020; Chetail & Mathey, 2009) whilst critically matching CV and CVC words on their number of syllabic neighbours. Even though their results once again showed a syllable structure effect – i.e., reliable syllable congruency effects only emerged for CV words – an important finding worth of being highlighted was the fact that there was a tendency for different types of CVC words to behave differently. In fact, in an a posteriori analysis the authors decided to split CVC words into those with a match between the orthographic (O) and phonological (P) first-syllable structure (e.g., *TUR.BO* [turbo] – [t'ur.bu] – note that in both cases the syllable presents a CVC structure – CVC_{O+P+} words) and those in which there was a mismatch between the orthographic and phonological first-syllable structure (e.g., *CAN.TOR* [singer] – [kæ.t'or] – in this case the first syllable present a CVC orthographic structure, but a CV phonological structure – CVC_{O+P} words). Separate results for CVC_{O+P+} and CVC_{O+P} words showed a tendency in the latter participants to be faster in the syllable-congruent condition than in the syllable-incongruent condition, while in CVC words with a match, no differences between the two conditions were found (see Campos et al., 2021 for more details). Whilst as mentioned the result failed to achieve statistical significance, likely due possibly to the lack of statistical power as only a small pool of items were used, they still showed a tendency for CVC_{O+P} words to behave similarly to CV words – i.e., faster RTs in the syllable-congruent condition when compared to the syllable-incongruent condition. This was a relevant finding as it leaves open the possibility that syllable effects in EP might be driven by the activation of phonological rather than orthographic information, which could account for the syllable structure effect observed in EP. Indeed, while orthographically the differences between CV and CVC words in EP are subtle (38% vs. 30.2%, respectively), when phonology is considered, the difference increases considerably. According to the P-PAL database (Soares et al., 2014, 2018), 43.9% of the phonologically defined EP words have a CV first-syllable structure whereas only 15.3% have a CVC first-syllable structure. This occurs because in EP while CV syllables almost always present a match between the orthographic and the phonological first-syllable structure (with few exceptions such as in the word *há* [exists] – [a], which presents a CV orthographic syllable structure but a V phonological syllable structure since in EP the letter < h > is silent), CVC syllables can either present a match or a mismatch between the orthographic and the phonological syllable representation. One of the most frequent causes for these mismatches stems from the

junction of the nucleus of a CVC orthographically defined syllable with a < m > or a < n > consonant in the coda position forming a nasal vowel, such in the above-mentioned case of the EP word *cantor* [singer].

The idea that syllable effects might be driven by the activation of phonological rather than orthographic information is not new as the syllable is, by definition, a phonological unit of processing. Indeed, several studies conducted in languages such as Spanish (e.g., [Álvarez et al., 2004](#)), French (e.g., [Chetail & Mathey, 2009](#); [Conrad et al., 2007](#)), and even Korean (e.g., [Kwon et al., 2011](#)) have already shown that this seems to be the case. Nonetheless, because phonological effects are harder to capture with masked priming paradigms (see [Forster & Davis, 1984](#); [Kinoshita & Lupker, 2003](#); [Lupker & Davis, 2009](#)), it would be helpful to further examine this issue through the use of a more time-sensitive technique such as event-related potentials (ERPs), which we did in the present study.

Although to the best of our knowledge, this paper presents the first study aimed to directly address these issues using ERPs, it is worth mentioning that previous electrophysiological studies examining syllable effects in visual word recognition have been conducted (e.g., [Ashby, 2010](#); [Barber et al., 2004](#); [Carreiras et al., 2005](#); [Chetail et al., 2012](#); [Goslin et al., 2006](#); [Hutzler et al., 2004](#); [Kwon et al., 2011](#)). For example, [Barber et al. \(2004\)](#), conducted a standard lexical decision task where they manipulated both the syllable frequency (high vs. low) and word frequency (high vs. low) of CV Spanish dissyllabic words containing those syllables. The authors observed that while words with high-frequent first syllables elicited a reduced amplitude in the P200 component compared to words with low-frequent syllables, high-frequent words elicited a reduced N400 amplitude when compared to low-frequent words. In addition, words with high-frequent syllables elicited a larger N400 amplitude when compared to words with low-frequent syllables. The syllable effect observed in the P200 component was interpreted as indexing early facilitation due to syllable activation, whereas syllable effects observed in the N400 component were taken as reflecting competition between words sharing the same first syllable with the target (syllabic neighbours).

Other ERP studies using the same (e.g., [Chetail et al., 2012](#); [Hutzler et al., 2004](#); [Kwon et al., 2011](#); but see [Goslin et al., 2006](#) for conflicting results) or different paradigms (e.g., [Carreiras et al., 2005](#)) have found similar results. For instance, [Carreiras et al. \(2005\)](#), using a colour-congruency paradigm, asked Spanish skilled readers to decide whether CV dissyllabic Spanish words and pseudowords that appeared segmented, through the use of two colours (red and green), according to their syllable boundary (i.e., syllable congruent condition – e.g., *casino*) or not (i.e., syllable-incongruent condition e.g., *casino*) corresponded to a real Spanish word (i.e., to perform a standard lexical decision task). Their results showed that targets (words and pseudowords) presented in the syllable-congruent condition elicited modulations in the P200 and the N400 components, as in previous works (e.g., [Barber et al., 2004](#); see also [Hutzler et al., 2004](#)). Differences in words and pseudowords processing only emerged in the N400 component showing that pseudowords elicited a larger N400 amplitude when compared to words, in line with other works (e.g., [Vergara-Martinez and Swaab, 2012](#)). The fact that modulations in the P200 component were observed for words and pseudowords alike supported the view that syllable effects (at least in the Spanish language) are pre-lexical, though the use of only CV words and pseudowords limits this interpretation. Since the CV stimuli in the syllable-congruent condition always present a letter less than in the syllable-incongruent condition, the results may also index this difference. One way to rule out this confound implies the use of CVC in addition to CV words. Note that only the observation that CV and CVC words elicit similar modulations in the P200 ERP component would genuinely indicate that the syllable is activated at the early stages of visual word processing, since for CVC targets the syllable-congruent condition would imply the processing of one letter more. Moreover, if syllable effects were observed for CV and CVC words and pseudowords alike, this would additionally prove that syllable effects are supported by

sublexical representations. It is also worth remarking that although the vast majority of the ERP studies tracking syllable effects in visual word recognition have reported syllable effects in the P200 component, modulations in earlier time windows have also been reported. For example, [Ashby \(2010\)](#) in one of the few ERP studies that have used CV (e.g., PONY) and CVC (e.g., PONDER) English words, preceded either by syllable-congruent (e.g., po## – PONY, pon### – PONDER) or syllable-incongruent primes (e.g., pon# – PONY, po#### – PONDER) observed modulations in the N100 component. Both CV and CVC words preceded by syllable-congruent primes produced a reduced N100 amplitude relative to those preceded by syllable-incongruent primes, which was taken as a marker of syllable effects in the English language (see however [Álvarez et al., 2016](#) for a discussion).

Following [Carreiras et al.'s \(2005\)](#) procedure, in the present study, we resorted to the colour-congruency paradigm to investigate the electrophysiological correlates of syllable effects in the processing of CV and CVC EP words and pseudowords, the latter including those in which there is a match (i.e., CVC_{O+P+}) or a mismatch (i.e., CVC_{O+P-}) between their orthographic and phonological first-syllable structures to further examine if syllable effects in EP are driven by the activation of orthographic and/or phonological information. If the syllable is indeed a unit for visual word recognition supported by sublexical representations, we expect to observe modulations in the P200 component for CV and CVC words and pseudowords alike for the syllable-congruent relative to the syllable-incongruent conditions, even though other effects may be also observed in earlier (N100) and later (N400) ERP components. Additionally, if phonological information is the driving force for the syllable activation in EP, we would also expect CVC_{O+P-} targets to elicit a different pattern of neural responses than CVC_{O+P+} targets presented in the syllable-congruent condition in the time windows reported above.

2. Method

2.1. Participants

Twenty-four female undergraduate students from the University of Minho ($M_{age} = 19.7$; $SD_{age} = 1.7$) took part in the experiment in exchange for course credits. All the participants were native speakers of EP, with normal hearing and normal or corrected-to-normal vision, and all were right-handed, as assessed by the Portuguese adaptation of the Edinburgh Handedness Inventory ([Oldfield, 1971](#), and see [Espírito-Santo et al., 2017](#) for the Portuguese adaptation). None of them reported any prior history of learning disabilities and/or neurological issues. A written informed consent form was obtained from all the participants. This study was approved by the local Ethics Committee (University of Minho, Braga, Portugal, SECSH 028/2018).

2.2. Materials

A total of 180 EP dissyllabic words from five to six letters in length and with a lexical frequency ranging from 0.0586 to 48.3894 per million words, were selected from the P-PAL lexical database ([Soares et al., 2014, 2018](#)). Sixty of these words present a CV orthographic and phonological first-syllable (e.g., *ze.bra* [zebra] – [z'ε.brɐ]), 60 a CVC orthographic and phonological first-syllable (CVC_{O+P+}, e.g., *ver.bo* [verb] – [v'εr.bu]), and the remaining 60 a CVC orthographic and a CV phonological first-syllable (CVC_{O+P-}, e.g., *can.tor* [singer] – [kɐ̃.t'or]). All of the words used are content words classified as grammatical nouns with the exception of one CV word (i.e., *sóbrio* [sober]) and three CVC_{O+P-} words (i.e., *denso* [dense], *manso* [tame], *tenso* [tense]), which are classified as adjectives.

The CV, CVC_{O+P+}, and CVC_{O+P-} words were matched in several variables known to affect EP word processing (see [Soares et al., 2015](#) and [Soares, Lages, Silva, et al., 2019](#)), namely per million-word frequency ($p = .352$), number of letters ($p = .869$), the classic *N* orthographic neighbourhood measure ($p = .262$), the number of more frequent orthographic

neighbours ($p = .971$), the mean frequency of the most frequent orthographic neighbours ($p = .581$), and the orthographic Levenshtein distance (i.e., OLD₂₀ measure - Yarkoni et al., 2008; $p = .175$). Moreover, CV, CVC_{O+P+}, and CVC_{O+P} words were also matched both in the type ($p = .373$) and token frequency of their first syllable ($p = .408$), as obtained from the P-PAL database. Semantic variables of familiarity (i.e., subjective frequency; $p = .718$), imaginability ($p = .560$), and concreteness ($p = .473$) were also controlled for the CV, CVC_{O+P+}, and CVC_{O+P} words for which data were available in the Minho Word Pool database (MWP; Soares et al., 2017) – 27 out of 60 for the CV words, 32 out of 60 for the CVC_{O+P+}, and 32 out of 60 for the CVC_{O+P} words. Table 1 depicts the psycholinguistic characteristics (means and standard deviations) of the words used in the experiment.

One hundred and eighty pseudowords were created for the purpose of the lexical decision task by replacing one or two letters in the medial positions of other EP words with similar characteristics to the experimental words. For instance, the pseudoword *li.jor* was created from the base EP word *li.cor* [liquor] by replacing the letter < c > with a < j > while respecting the orthographic and phonotactic restrictions of EP. As with word targets, 60 pseudowords had a CV first-syllable structure (e.g., *fó.pio* [fɔ-pju]), 60 a CVC_{O+P+} first-syllable structure (e.g., *vul.ma* [v'ut-mə]), and 60 a CVC_{O+P} first-syllable structure (e.g., *pen.va* [p'ẽ-və]). This method followed many other studies conducted in EP (e.g., Campos et al., 2018; Perea et al., 2013; Soares et al., 2020, 2021; Soares, Lages, Oliveira, et al., 2019) and in other languages (e.g., Balota et al., 2004, 2007; Cuetos et al., 2011; Ferrand et al., 2010; Yap et al., 2010), as research tools supporting the generation of legal pseudowords are not available for EP. Nevertheless, extreme caution was taken to ensure that the pseudowords resembled real EP words and conform to the orthographic rules of EP.

Each of the words and pseudowords was segmented according, or not, to its syllable boundary following the orthographic syllabic rules of EP by using the black (i.e., R = 0, G = 0, B = 0) and dark-grey colours (i.e., R = 84, G = 87, B = 90) against a white background (i.e., R = 255, G

= 255, B = 255) according to the RGB colour system. The two colours used in the syllable-congruent and syllable-incongruent conditions were counterbalanced between participants (e.g., a CV word as *zebra* [zebra] was presented as *zebra* in the syllable-congruent condition and as *zebra* in the syllable-incongruent condition for half of the participants, and as *zebra* in the syllable-congruent condition and as *zebra* in the syllable-incongruent condition for the other half of participants). Although Carreiras et al. (2005) have used red and green to segment the targets, we opted to use black and dark-grey instead because participants are used to seeing printed words in these colours, therefore creating a more ecological experimental setting. Furthermore, we have opted to use black and grey to avoid potential positive/negative effects related to the use of red and green colours, which are commonly linked to positive and/or negative connotations in several contexts (e.g., Buechner et al., 2014; Elliot & Maier, 2007, 2012, 2014). Each word and pseudoword was hence presented twice, once in the syllable-congruent condition, and then in the syllable-incongruent condition (e.g., *zebra* would be presented as *zebra* or *zebra* first, and then again as *zebra* or *zebra*, respectively), evenly distributed across the three types of words/pseudowords (CV, CVC_{O+P+}, and CVC_{O+P}).

2.3. Procedure

Participants were tested individually in a light- and sound-attenuated electrically shielded room, a meter away from the computer screen. They were asked to decide as quickly and accurately as possible if the letter string presented at the centre of a 22-inch computer screen was a real EP word or not, by pressing the key “1” of the keyboard for a “word” response and the key “2” for a “nonword” response (i.e., to perform a classic lexical decision task). The task comprised 720 trials presented in two blocks of 360 trials each, with each word and pseudoword being presented twice (one presentation per block) – i.e., one time in the syllable-congruent condition and the other in the syllable-incongruent condition. The presentation of the two blocks was counterbalanced across participants. Trials in each block began with the presentation of a fixation cross (+) at the centre of the computer screen for 2,500 ms. Subsequently, a word or a pseudoword was presented in 36-point Courier New (2.3° × 2.86°), in the same stimulus position for 1,000 ms - or until a response (word/nonword) was produced - with a variable interstimulus interval (ISI) from 1000 to 1500 ms. Also, an additional ISI of 3,000 ms was presented every four trials to avoid fatigue. Trials in each block were presented randomly for each participant.

Prior to the experimental task, participants responded to 12 practice trials to familiarize them with the task. The task was programmed using the Psychopy software (Pierce, 2007). The whole procedure lasted approximately 45 min per participant.

2.4. EEG data acquisition and processing

The EEG data were recorded while participants performed the lexical decision task with the 64 channels BioSemi Active-Two system (BioSemi, Amsterdam, The Netherlands) organised according to the 10/10 system and sampled at a rate of 512 Hz. Electrode impedances were kept below 20 kΩ and they were filtered online at a rate of 0.1–100 Hz band-pass filter (zero phase shift Butterworth). Vertical and horizontal electro-oculogram activity was recorded to monitor eye movements and blinks.

The EEG data were processed with the Brain Vision Analyzer, version 2.1.1. (Brain Products, Munich, Germany). It was digitally filtered offline with a 0.1–70 Hz band-pass filter (8 dB/octave). Stereotyped noise, which was mostly ocular movements and blinks, was removed by independent component analysis (ICA). The signal was re-referenced offline to the algebraic average of the mastoids and segmented in epochs from –200 to 1,000 ms. Epochs that exceeded ± 80 μV at any scalp electrode were rejected. Before averaging, a baseline correction was applied (from –200 to 0 ms). There were no significant differences

Table 1

Psycholinguistic Variables in Which CV, CVC_{O+P+} and CVC_{O+P} Words Used in the Present Study Were Matched as obtained from the P-PAL database (Soares et al., 2018) and Measures of Familiarity (i.e., subjective frequency), Imaginability and Concreteness as obtained from the Minho Word Pool database (MWP – Soares et al., 2017).

Psycholinguistic variables	CV words M (SD)	CVC _{P+O+} words M (SD)	CVC _{P+O+} words M (SD)	p
Word length (number of letters)	5.17 (0.38)	5.18 (0.39)	5.27 (0.45)	0.869
Word frequency (per million)	7.95 (10.01)	9.01 (12.67)	8.70 (11.56)	0.352
Orthographic neighbourhood Size (N)	6.00 (4.84)	5.98 (4.45)	7.22 (4.85)	0.262
Mean frequency of the orthographic neighbours	16.10 (59.58)	18.05 (42.79)	16.75 (22.52)	0.971
	33.54 (113.86)	53.79 (109.21)	47.96 (68.78)	0.518
Mean frequency of higher frequency orthographic neighbours	1.60 (0.33)	1.60 (0.35)	1.51 (0.30)	0.175
Orthographic Levenshtein Distance (OLD ₂₀)				
Number of syllabic neighbours sharing the first syllable	40.82 (35.06)	35.65 (19.42)	34.87 (17.33)	0.373
Summed frequency of the syllabic neighbours sharing the first syllable	503.51 (674.76)	370.30 (426.99)	485.81 (639.46)	0.408
	4.14 (1.13)	4.23 (1.05)	4.02 (0.96)	0.718
Subjective Frequency (1–7)	5.21 (0.91)	5.12 (0.87)	4.97 (0.85)	0.560
Imaginability (1–7)	5.30 (1.08)	5.40 (1.25)	5.04 (1.23)	0.473
Concreteness (1–7)				

between the number of rejected trials, due to artefacts or incorrect responses, either between the syllable-congruent and incongruent conditions (i.e., congruent condition = 120.88 ± 29.61 and incongruent condition = 118.17 ± 27.66 , $p = .740$), or between the three different syllable structures in each syllable-congruency condition (CV: syllable congruent = 39.92 ± 10.95 ; syllable incongruent = 40.03 ± 10.95 ; CVC_{O+P+}: syllable congruent = 40.79 ± 10.01 ; syllable incongruent = 38.25 ± 8.62 ; and CVC_{O+P-}: syllable congruent = 40.79 ± 10.01 ; syllable incongruent = 40.17 ± 9.89), all p 's > 0.770.

2.5. Data analysis

Behavioural and EEG analyses were conducted with the IBM-SPSS software (Version 27.0. Armonk, NY, USA: IBM Corporation). Incorrect responses (13.6% of the responses in the word data and 22.2% of the responses in the pseudoword data) were removed from the analyses. Furthermore, RTs that were below and above three standard deviations from the mean of each participant per experimental condition were also excluded (2.9% of word data and 0.69% of pseudoword data), following common procedures in psycholinguistic research (e.g., Campos et al., 2018; Soares et al., 2020).

Individual ERPs were averaged separately for the correct responses per experimental condition over a 1,200 ms epoch. Grand average waveforms were then calculated across individuals for each type of word/pseudoword (CV, CVC_{O+P+}, and CVC_{O+P-}) both in the syllable-congruent and syllable-incongruent conditions. The N100 (80–120 ms), P200 (130–170 ms), and N400 (350–450 ms) ERP components were analysed on their mean amplitudes in fronto-central (Fz, FCz, FC1, FC2, and Cz) and parieto-occipital (Pz, POz, PO3, PO4, and Oz) regions and selected based on previous literature (e.g., Antal et al., 2001; Hutzler et al., 2004; Savill & Thierry, 2012; Soares et al., 2020; Sulpizio & Job, 2018; Vogel & Luck, 2000; Weber-Fox et al., 2003), on the visual inspection of the data (for details see Figure S.1 in the supplementary materials section), and on the conduction of a point-by-point analysis following current practices in the literature (see, for instance, Strijkers et al., 2015; Vergara-Martínez et al., 2020). Specifically, for the latter, we have compared ERPs in the syllable-congruent and syllable-incongruent conditions at each electrode by running a two-tailed paired t -tests at every two sampling points (4 ms), beginning from target presentation (0 ms) until 500 ms post-stimulus onset. To correct for multiple comparisons, a time window was considered significant if at least a consecutive sequence of 20 ms exceeded the 0.05 significance level.

Repeated-measures ANOVAs were conducted on the behavioural (RT and accuracy) and EEG (mean amplitudes in each ERP component) data based on a Lexicality (word vs. pseudoword) $\times$ Syllable structure (CV, CVC_{O+P+}, CVC_{O+P-}) $\times$ Syllable congruency (congruent vs. incongruent) within-subject design. In the EEG data two separate ANOVAs were conducted for each of the topographic regions of interest (i.e., fronto-central and parieto-occipital), moreover, an additional within-subject factor, Electrode (5 electrodes) was also included in the analysis.

In both the behavioral and EEG analyses, only main or interaction effects that reached statistical or marginal significance in comparisons of interest are reported. The Greenhouse–Geisser correction for non-sphericity was used when appropriate. Posthoc tests for multiple comparisons were adjusted with Bonferroni correction. Measures of effect size (η^2_p) for a single effect are reported in combination with the main effects of the condition.

3. Results

3.1. Behavioural data

The mean and standard deviations of the RTs for correct responses and the percentage of errors for the CV, CVC_{O+P+}, and CVC_{O+P-} words and pseudowords in each syllable-colour-boundary condition

(congruent and incongruent) are presented in Table 2.

On the latency data, the ANOVA showed a significant main effect of lexicality, $F(1, 23) = 38.845$, $MSE = 0.246$, $p < .001$, $\eta^2_p = .628$ indicating, unsurprisingly, that participants were faster at recognizing words than pseudowords. A syllable structure main effect was also observed, $F(2, 46) = 3.219$, $MSE = 0.001$, $p = .049$, $\eta^2_p = .123$, although comparisons across syllable conditions failed to reach significance - only a tendency to respond faster to CVC_{O+P-} targets (words and pseudowords) than CV targets (words and pseudowords) was observed ($p = .061$). Furthermore, the two-fold lexicality $\times$ syllable structure interaction, $F(2, 46) = 3.931$, $MSE = 0.001$, $p = .027$, $\eta^2_p = .146$ indicated that the tendency to respond faster to CVC_{O+P-} than CV targets was only significant for pseudowords ($p = .002$), and also that participants were faster at recognizing CVC_{O+P+} pseudowords than CV pseudowords ($p = .036$). For words, no differences reached statistical significance. Finally, the three-fold lexicality $\times$ syllable structure $\times$ syllable congruency interaction also reached significance, $F(2, 46) = 5.638$, $MSE = 0.001$, $p = .006$, $\eta^2_p = .197$. Pairwise comparisons revealed that participants were faster at recognizing pseudowords with a CVC_{O+P-} structure presented in the syllable-congruent condition than in the syllable-incongruent condition ($p = .003$). No other differences were significant.

In the accuracy data, the ANOVA revealed a main effect of lexicality, $F(1, 23) = 6.803$, $MSE = 0.503$, $p = .016$, $\eta^2_p = .228$, showing that participants were more accurate at recognizing words than pseudowords, as expected. The interaction lexicality $\times$ syllable structure was also significant, $F(2, 46) = 3.231$, $MSE = 0.009$, $p = .049$, $\eta^2_p = .123$ indicating that participants committed more errors when responding to CV pseudowords than to CVC_{O+P+} pseudowords ($p = .020$). For words, no differences were observed. No other effects reached statistical significance.

3.2. ERP data

Fig. 1 presents the grand average waveforms and the scalp distributions for the syllable-congruent and syllable-incongruent conditions for the CV, CVC_{O+P+}, and CVC_{O+P-} words and pseudowords at POz in the N100, P200, and N400 time-windows. To allow better visualization, the ERP waveforms presented in Fig. 1, as well as in the other ERP figures, were filtered with a 15 Hz low-pass filter.

3.2.1. n100

In this time window, the ANOVA conducted on parieto-occipital regions revealed a significant syllable structure $\times$ syllable congruency interaction effect, $F(2, 46) = 3.296$, $MSE = 8.622$, $p = .046$, $\eta^2_p = .332$. Pairwise comparisons showed that CV words and pseudowords elicited reduced amplitudes in the syllable-congruent than in the syllable-incongruent conditions ($p = .028$). No other main or interaction effects reached statistical significance. The ANOVA conducted on fronto-central regions did not show any significant effects. Fig. 2 represents that effect.

Table 2

Mean and SD (in brackets) of Response Times (RTs) and Percentage of Errors (%E) per Condition.

Lexicality	Target type	Prime type			
		Congruent		Incongruent	
		RT	%E	RT	%E
Words	CV	652 (40)	12.4 (7.9)	655 (46)	14.5 (10)
	CVC _{O+P+}	653 (42)	12.6 (7.6)	662 (45)	14.3 (7.7)
	CVC _{O+P-}	653 (41)	15.3 (8.9)	655 (46)	14.3 (6.9)
Pseudowords	CV	721 (62)	23.5 (18.7)	717 (56)	24.4 (18.7)
	CVC _{O+P+}	716 (62)	22.0 (15.6)	708 (64)	20.5 (16.6)
	CVC _{O+P-}	703 (62)	22.1 (16.1)	715 (55)	21.0 (16.5)

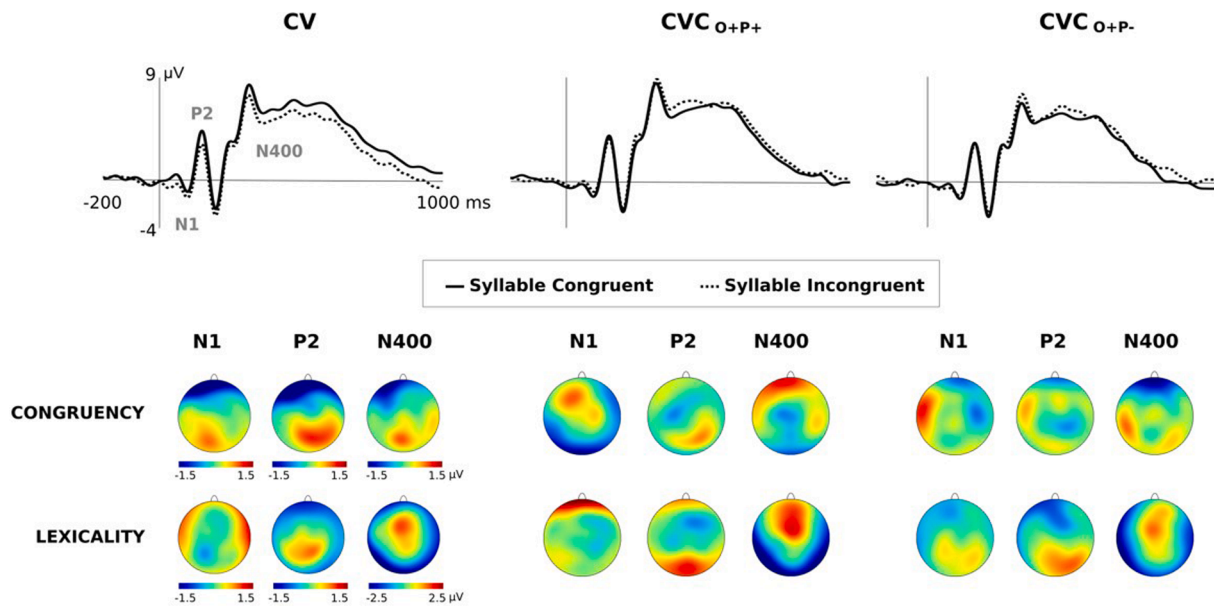


Fig. 1. Modulations in N100, P200, and N400 in the syllable congruent and syllable incongruent conditions by target type.

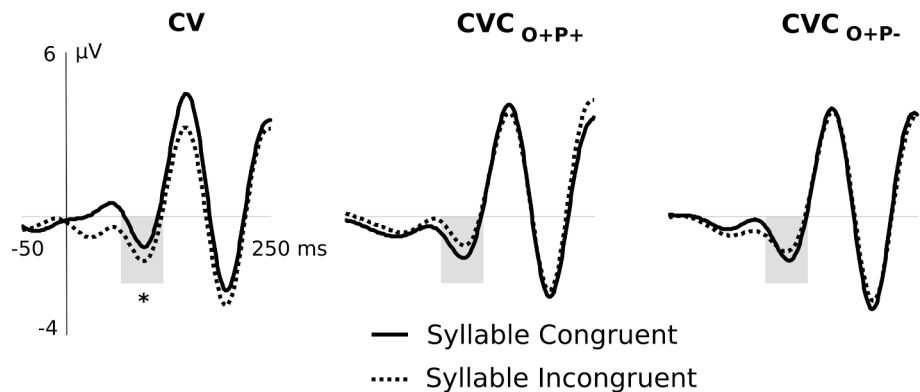


Fig. 2. Graphical representation of the N100 in the syllable-congruent and syllable-incongruent conditions in parieto-occipital areas for each of the three target types.

3.2.2. p200

In this ERP component, the ANOVA conducted on parieto-occipital regions showed two significant main effects: a main effect of lexicity, $F(1, 23) = 11.452$, $MSE = 39.511$, $p = .003$, $\eta^2_p = .332$, indicating that words elicited larger P200 amplitudes than pseudowords; and a main effect of syllable congruency, $F(1, 23) = 4.729$, $MSE = 20.280$, $p = .040$, $\eta^2_p = .171$, showing that CV, CVC_{O+P+}, and CVC_{O+P-} words and pseudowords produced larger P200 amplitudes in the syllable-congruent than in the syllable-incongruent conditions (see Fig. 3).

No other main or interaction effects reached statistical significance. Furthermore, no significant effects were observed in the ANOVA conducted in fronto-central regions.

3.2.3. N400

The ANOVA conducted for fronto-central regions revealed a main effect of lexicity observed in this time window, $F(1, 23) = 47.265$, $MSE = 205.316$, $p < .001$, $\eta^2_p = .673$. This effect revealed that words produced a reduced N400 amplitude when compared to pseudowords. A significant lexicity $\times$ syllable congruency interaction was also found in the fronto-central region, $F(1, 23) = 4.701$, $MSE = 10.360$, $p = .041$, $\eta^2_p = .170$. Pairwise comparisons failed, however, to reach significance and only a tendency for words with a CV, CVC_{O+P+}, and CVC_{O+P-} structure to produce a larger N400 amplitude in the syllable-congruent than in the

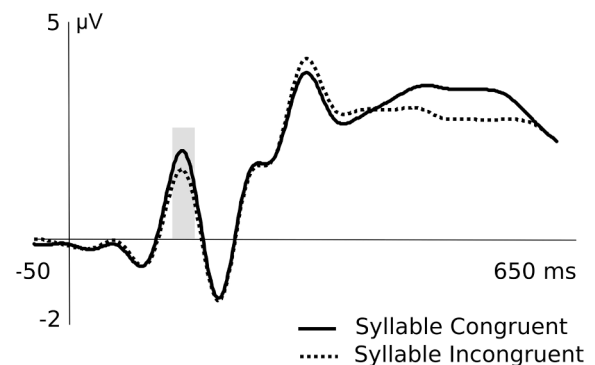


Fig. 3. Graphical representation of the main syllable congruency effect in the P200 component in parieto-occipital areas.

syllable-incongruent condition approached significance ($p = .056$). Fig. 4 depicts this two-fold interaction.

Furthermore, the ANOVA conducted in the parieto-occipital region, showed a marginally significant syllable structure $\times$ syllable-congruency effect, $F(2, 46) = 3.104$, $MSE = 11.208$, $p = .054$, $\eta^2_p = .119$. The interaction revealed that CV words and pseudowords tended to produce

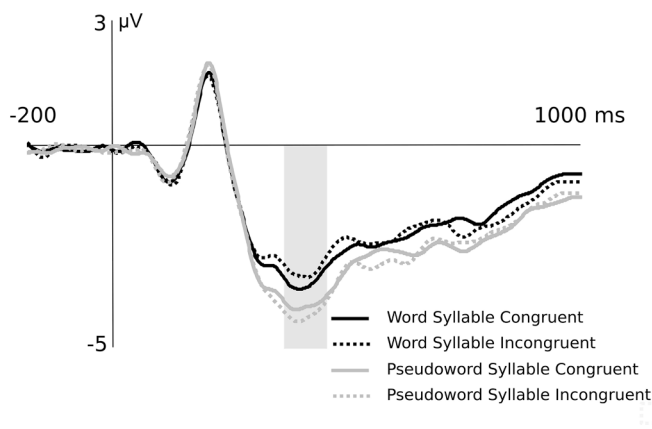


Fig. 4. Graphical representation of the interaction between lexicality and syllable congruency found in the N400 component in fronto-central regions.

a larger N400 amplitude in the syllable-congruent than in the syllable-incongruent condition ($p = .029$). No other significant effects were found in this time-window.

4. Discussion

The role of the syllable in visual word recognition has been widely studied in the psycholinguistic literature, though several questions remain unanswered. This study was designed to address some of these issues, namely the largely overlooked syllable structure effect, observed in EP as well as in other languages, and the extent to which syllable effects are supported by lexical and/or sublexical representations. In addition, we have also analysed whether syllable effects in EP are driven by phonological and/or orthographic information, as the results of Campos et al. (2021) left open phonology as a possible factor contributing to the syllable structure effect observed in EP. We have explored this issue by taking advantage of a particular feature of the EP language, which encompasses the fact that words with a CVC orthographic first-syllable structure may present either a match or a mismatch concerning their phonological first-syllable structure (CVC_{O+P+} and CVC_{O+P-} words, respectively). We reasoned that if phonological information was driving syllable activation at early stages of visual word recognition, CVC_{O+P-} and CVC_{O+P+} targets presented in the syllable-congruent condition should elicit a different pattern of neural response. Moreover, by comparing the neural responses elicited by the processing of words and pseudowords, we also aimed to shed light on the sublexical nature of syllable effects in EP since previous behavioural studies conducted in this language have failed to show reliable syllable effects for pseudowords (e.g., Campos et al., 2018, 2021).

Behavioural results showed that participants took longer and committed more errors when rejecting pseudowords than accepting words, hence demonstrating that the task worked properly. Nonetheless, unlike previous behavioural lexical decision masked priming studies manipulating either first-syllable frequency (e.g., Álvarez et al., 1998, 2000, 2001; Carreiras et al., 1993; Conrad et al., 2007, 2008; Perea & Carreiras, 1998; Stenneken et al., 2007) or syllable congruency (e.g., Álvarez et al., 2004; Campos et al., 2018, 2020, 2021; Chetail & Mathey, 2009), no signs of syllable effects were observed for word targets. The only behavioural effect that reached statistical significance was in the pseudoword data. Although these results might seem unexpected, it is important to emphasize that they are consistent with previous findings using the colour-congruency paradigm to examine syllable effects (e.g., Carreiras et al., 2005; Katz & Baldasare, 1983). As Katz and Baldasare (1983) suggested, presenting stimuli in two different colours might not suffice to disrupt word recognition in skilled adult readers at least as captured by behavioural measures. Moreover, this disruption would be even lower, possibly, when using two colours that readers are used to

encountering in print, as it is the case of black and dark-grey (the colours used in this study). Nevertheless, syllable effects were curiously found for our pseudoword data, with participants being faster and more accurate at rejecting pseudowords presenting a CVC_{O+P-} first syllable in the syllable-congruent condition than in the syllable-incongruent condition. Although this result was not expected, it is possible that because CVC_{O+P-} pseudowords present less syllabic variability than pseudowords with the CVC_{O+P+} and CV first syllable (note that only when the nucleus of a CVC syllable is followed by an < n > or < m > in the coda position the mismatch between the orthographic and phonological syllable structure occurs, as in the case of *can.tor* [singer] – [kẽ.t'or]), this might have contributed to producing some kind of pop-out effect. Thus, it might make these pseudowords more distinctive, and participants more prone to reject them as ‘words’ in the syllable-congruent than in the syllable-incongruent condition.

Signs of syllable effects for words were nevertheless observed in the ERP data though there were different patterns for each component. Specifically, the ERP data showed modulations in parieto-occipital areas in the N100 component indicating that CV words and pseudowords produced a reduced amplitude in the syllable-congruent condition when compared to the syllable-incongruent condition, suggesting this component to be sensitive to the first-syllable structure of the targets. Although this result goes in line with Ashby’s (2010) findings, it is important to note that the author found a reduced N100 amplitude in central and posterior regions in the syllable-congruent relative to the syllable-incongruent condition for CV and CVC words alike, which led them to suggest this early component to index syllable activation in the English language. However, since in our case N100 modulations were only observed for CV targets, this result suggests that the N100 component indexes early visuo-orthographic processes, where visual features are mapped into sublexical representations rather than genuine syllable effects (see Duñabeitia et al., 2012; Madec et al., 2016; Massol et al., 2016; Sulpizio & Job, 2018 for a similar N100 interpretation, though targeting other linguistic phenomena). It is also important to stress that the N100 has been described as indexing attention and perception-like processes (e.g., Hillyard et al., 1973; Mangun & Hillyard, 1991; Vogel & Luck, 2000; Zhang et al., 2013), with some authors claiming N100 amplitudes reflect discrimination processes related to the characteristics of the stimuli under analyses (e.g., Hopf et al., 2002; Vogel & Luck, 2000). In the context of the present study, it is possible that these two N100 interpretations are not mutually exclusive. Indeed, while CVC_{O+P+} and CVC_{O+P-} targets in syllable-congruent and syllable-incongruent conditions form legal EP syllables, as in the cases of *verbo* and *verbo* or *cantor* and *cantor* respectively as *ver*, *ve*, *can*, and *ca* are existent EP syllables; the majority of the CV targets used in this experiment (65.8%) form illegal syllables when presented in the syllable-incongruent condition, as in the case of *zebra* since *zeb* is an inexistent syllable in EP. These characteristics of the CV targets could have made them more salient, hence increasing the deployment of attentional resources to CV targets in the syllable-incongruent than in the syllable-congruent conditions, as reflected in the N100 enhancement.

Evidence of genuine syllable effects was nevertheless found in the P200 component in parieto-occipital areas, and, importantly, for EP CV, CVC_{O+P+}, and CVC_{O+P-} targets. The fact that the main effect of syllable congruency was observed for words and pseudowords alike, and also regardless of their first-syllable structure, strongly suggests that this syllable effect is a genuine one. Not only does syllable activation precede lexical activation, as shown by the effect found in pseudowords, but additionally, since it was also observed for CV, CVC_{O+P+}, and CVC_{O+P-} targets, this would discard the possibility that it is the targets in the syllable-congruent condition having one less letter that is explaining the advantage of this condition related to the syllable-incongruent condition, as the contrary would be true for CVC targets. These findings not only support previous studies showing modulations in this ERP component in similar scalp regions for syllable manipulations (e.g., Barber et al., 2004; Carreiras et al., 2005; Chetail et al., 2012; Hutzler

et al., 2004; Kwon et al., 2011), but critically extend them by demonstrating that the effect found in this waveform indexes genuine syllable activation. Note that Carreiras et al. (2005) have only used CV targets, preventing them from being certain that the effect stemmed from syllable activation, as mentioned before. Furthermore, the fact that we have observed evidence of syllable activation for the different types of first-syllable structures and even types of stimuli (word vs. pseudowords) provides strong evidence for the role of the syllable as a sublexical unit at the early stages of processing, as claimed by several authors (e.g., Álvarez et al., 2004; Campos et al., 2018, 2020, 2021; Carreiras et al., 1993; Chetail & Mathey, 2009; Conrad et al., 2010; Kwon et al., 2011). Thus, the absence of reliable syllable effects for CVC words and even for CV and CVC pseudowords in previous behavioural masked priming lexical decision studies (e.g., Álvarez et al., 2004; Campos et al., 2018, 2020, 2021; Chetail & Mathey, 2009) seems to rely on the characteristics of the tasks/paradigms used to test syllable activation, which do not seem to be sensitive enough to capture that effect beyond CV words. Moreover, the fact that syllable effects were observed at this time window for words and pseudowords alike reinforces the view that syllable effects in EP are pre-lexical in nature, as observed in other languages (e.g., Carreiras et al., 2005; Chetail et al., 2012; Hutzler et al., 2004; Kwon et al., 2011).

It is also worth noting that the absence of significant differences between the processing of CVC_{O+P+} and CVC_{O+P-} targets in the P200 ERP component does not support the assumption that phonology is the main source driving syllable effects in EP, unlike what has been observed in other languages, though using different tasks and paradigms (e.g., Álvarez et al., 2004; Chetail & Mathey, 2009; Conrad et al., 2007; Kwon et al., 2011, 2011). The fact that CVC_{O+P-} targets presented in the syllable-congruent condition produced similar effects as CVC_{O+P+} and CV targets presented in the same condition, suggests that it is the orthographic and not the phonological syllable that is activated at the early stages of visual word recognition, as observed by Chetail et al. (2012) in a study using ERPs with French participants. Taken together, these findings seem to suggest that in languages where there is not a direct mapping between orthography and phonology, as EP or French, phonology might have a less prominent role in syllable activation, unlike what is observed in transparent languages such as Spanish. This is also consistent with many studies suggesting that while, in more transparent languages, readers rely more on the use of phonological codes, in more opaque languages, readers rely more on alternative strategies that are based on visual and orthographic cues (see Harm & Seidenberg, 2004; Katz & Frost, 1992 and also Soares, Lages, Oliveira, et al., 2019 for an extended discussion).

Lastly, in the N400 component, besides the unsurprising lexicity effect, observed in frontal-central sites, showing that EP words produced a reduced amplitude when compared to EP pseudowords, a result also observed in previous ERP studies (e.g., Carreiras et al., 2005; Vergara-Martinez and Swaab, 2012), the lexicity and syllable congruency interaction effect revealed a tendency ($p = .056$) for CV, CVC_{O+P+}, and CVC_{O+P-} targets in the syllable-congruent condition to produce a larger N400 amplitude than CV, CVC_{O+P+}, and CVC_{O+P-} words in the syllable-incongruent conditions. This result was not observed for pseudowords, hence suggesting that at later stages of visual word recognition syllable effects are only maintained for words, due likely to some sort of top-down effect generated by words sharing the same first syllable with the target words. It is also important to mention that the larger N400 amplitude for words presented in the syllable-congruent condition closely reproduces previous findings with CV words presented in the syllable-congruent condition as in the study by Carreiras et al. (2005), and also in studies manipulating syllable frequency in a standard lexical decision task where CV words with a high-frequent first syllable also elicited larger N400 amplitudes when compared to CV words with a low-frequent first syllable (e.g., Barber et al., 2004; Chetail et al., 2012; Hutzler et al., 2004; Goslin et al., 2006). The larger N400 amplitude for words presenting high- rather than low-frequency CV first syllable in

these studies has been taken as indexing competition between lexical candidates that share the same first syllable (i.e., syllabic neighbours) and that compete with the target for recognition (see Conrad et al., 2010 but see also Chetail et al., 2012 for more details). Additionally, in parieto-occipital areas we have observed another syllable effect in the N400 component, an interaction between syllable structure and syllable congruency. Indeed, there was a tendency for CV targets, in particular words (i.e., posthoc analyses revealed that only for CV words was the effect significant, $p = .023$; for pseudowords, it does not reach significance, $p = .203$), to produce larger N400 amplitudes in the syllable-congruent condition than in the syllable-incongruent condition. This result also goes in line with those observed by Carreiras et al. (2005) that found evidence of a larger N400 amplitude in more posterior areas for targets presented in the syllable-congruent condition when compared to the syllable-incongruent condition, though the authors only used CV targets.

Taken together, the results observed in both sites suggest that the competition generated from the syllable is produced from top-down activation since modulations for the N400 component are only significant for words. Additionally, results in parieto-occipital regions, suggest greater competition generated by CV words when compared to CVC_{O+P+} and CVC_{O+P-} words. Although, as mentioned, the stimuli used in the present study were controlled for in several psycholinguistic variables known to affect EP word processing, including token and type first-syllable frequency, the tendency observed in the N400 for CV words seems to suggest that the CV skeletal structure (i.e., the combination of consonants and vowels in a letter string such as *zebra* = CV.CCV, *verbo* = CVC.CV or *cantor* = CVC.CV), and not only the syllable per se, also plays some role. Indeed, recent studies have highlighted the importance of the CV skeletal structure at early stages of visual word recognition (e.g., Blythe et al., 2014; Chetail & Drabs, 2014; Chetail et al., 2016; Perea et al., 2018). The fact that the majority of words contain a CV combination, both when it forms a syllable, such in the word *ba.nho* [bath - CVCCV] or when it is only a letter cluster but not a syllable, as in the word *bal.de* [bucket - CVCCV] – note that most CVC words in the EP language contain a CV syllable embedded within them, but the contrary does not typically occur – might explain why even when CV and CVC words are matched on their number of syllabic neighbours, such as recently done by Campos et al. (2021), there is still an advantage of CV words over CVC words. As such, it is possible that this larger number of lexical candidates activated by the CV skeletal structure of CV words is indexed by the larger N400 amplitudes relative to CVC words with a match and mismatch, showing that there is a higher level of competition generated by the CV letter cluster, both as a syllable and not.

Regarding our results, a final consideration worthy of note should be made. Due to the fact that two types of CVC words were used in the present study, participants saw twice the number of CVC words when compared to CV words (when orthography was considered). While one could argue that this might have facilitated the emergence of syllable effects for CVC words, if this was the case then it would also be expectable then that the same results would be observed for CV and CVC words in all sites and across components, which was not the case. Note that different results emerged when comparing CV and CVC words in the N100 component, and in the N400 component in parieto-occipital areas, where only for CV words did the effects reached significance. Still, it would be important for future studies, whenever possible, to assure the same number of CV and CVC words being used.

5. Conclusions

In sum, in the present study, using a technique that is more sensitive to the temporal course of visual word recognition, ERPs, we have shown that the syllable is, in fact, a sublexical unit used in lexical access in EP. Here we have demonstrated that early effects are observed in words and pseudowords alike, and are not restricted to CV first-syllable structure words. Furthermore, results also suggest that orthography, rather than

phonology, seems to be the driving force of syllable effects in EP. At later stages of visual word recognition, however, it is important to consider that our results seem to show that syllable effects are only maintained for word targets, and are more pronounced for those with a CV first-syllable structure. This is likely reflecting the top-down activation sent from the lexical entries to the syllable, both those that share the syllable with the target-word but also the CV skeletal structure, which would create greater competition for CV words, reflected in larger N400 amplitudes, even when the number of syllabic neighbours is matched between CV and CVC words.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.bandl.2022.105104>.

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