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ORIGINAL ARTICLE

Does a mark make a difference? Visual similarity effects with accented vowels

Manuel Perea[1,2] · Ana Baciero[1,2,3] · Ana Marcet[1]

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Abstract

Visual similarity effects are pervasive in masked priming (e.g., T4BLE→TABLE; obiect→OBJECT; docurnent→DOCUMENT) and can be easily explained in terms of uncertainty regarding letter identity. However, recent research failed to show visual similarity effects for primes containing accented vowels (e.g., féliz-FELIZ behaves as fáliz-FELIZ [happy in Spanish]). This null effect has been taken to suggest that accented and non-accented vowels (e.g., é and e) activate completely distinct representations. However, priming effects are reinstated for non-accented vowels (e.g., facil-FÁCIL < fecil-FÁCIL [easy in Spanish]). Here we tested the hypothesis that the lack of priming effects for primes containing accented vowels is a simple consequence of the saliency of the accent marks. To investigate this issue, we conducted a masked priming lexical decision experiment in which we minimized the saliency of the diacritical marks by using primes containing the letter i (i.e., a letter that contains itself a glyph over the letter). We manipulated prime-target visual similarity and the presence/absence of an accented vowel in the prime (e.g., obieto-OBJETO vs. obaeto-OBJETO; obíeto-OBJETO vs. obáeto-OBJETO [object in Spanish]). Results showed a sizeable visual similarity effect regardless of whether the prime was accented or not. Therefore, these findings suggest that, at least in scripts like Spanish, there is nothing special about the processing of accented vs. unaccented vowels once the saliency of the diacritical marks is reduced.

Introduction

Nearly all Latin-based orthographies (English being an exception) contain vowels with diacritical marks (e.g., é, è, ê, and ë in French). The term *diacritic* comes from the Ancient Greek word *διακριτικός* meaning "serving to distinguish" (Merriam-Webster 2020). Although diacritical vowels can be used to distinguish between words (e.g., él [he] vs. el [the] in Spanish), nowadays their main function is as phonological markers (Wells 2000). Specifically, diacritics may indicate: (1) vowel quality (e.g., French: élève→/eˈlɛv/); (2) word stress (e.g., Spanish: célula→/ˈθelula/); (3) both vowel quality and word stress (e.g., Catalan: ciències→/siˈɛn.si.əs/); (4) both vowel quality and tone (e.g., Vietnamese: thể→/tʰe/[mid falling tone]); or (5) vowel length (e.g., Czech: létat→/ˈlɛːtat/).

The prevalence of diacritical vowels in most Latin-based languages raises the theoretical question of how diacritical vowels (e.g., é) are represented in the word recognition system. Leading hierarchical models of written word recognition (e.g., Dehaene, Cohen, Sigman, & Vinckier 2005; Grainger, Rey, & Dufau 2008) assume that the visual input is progressively mapped onto broader and more abstract layers of neurons, starting from those that encode letter fragments and letter shapes (e.g., e = *e* ≠ E) to those groups of neurons that encode abstract letter units (e.g., e = *e* = E). The identity and position of these abstract letter units are the fundamental ingredients underlying lexical access (see Grainger 2018, for a recent review). However, these neurally-inspired models were conceived for the English orthography, thus remaining silent as to how diacritical vowels are represented in

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✉ Manuel Perea
mperea@uv.es

1 Universitat de València, Valencia, Spain

2 Universidad Nebrija, Madrid, Spain

3 DePaul University, Chicago, USA

the word recognition system.[1] A similar argument applies to leading computational models of visual word recognition, which currently only simulate non-diacritical letters (e.g., Adelman 2011; Davis 2010; Norris & Kinoshita 2012).

Recent research, using a procedure that taps the initial moments of word processing—namely Forster & Davis' (1984) masked priming technique, has been taken to suggest that accented vowels do not activate the same letter units as their non-accented counterparts (see Chetail & Boursain 2019, for evidence in French; see Domínguez & Cuetos 2018; Perea, Fernández-López, & Marcet 2020, for evidence in Spanish). These experiments consistently reported shorter response times to target words (e.g., JETON [token] in French; FELIZ [happy] in Spanish) when preceded by an identity prime (jeton-JETON; feliz-FELIZ) than when preceded by a diacritic prime (jéton-JETON; féliz-FELIZ). Furthermore, the diacritic condition was not more effective than an orthographic control condition (e.g., juton-JETON; fáliz-FELIZ). Notably, despite the differing role of diacritics in French and Spanish (vowel quality vs. word stress, respectively), the pattern of effects was remarkably similar. Taken together, these findings suggest that, even in the initial stages of word processing, "base letters and their diacritic counterparts activate separated letter representations" (Chetail & Boursain 2019, p. 351).

However, the lack of a processing advantage of the diacritic condition over its orthographic control is at odds with the presence of visual similarity effects in the initial stages of printed word recognition. Prior masked priming experiments have reported priming effects not only with letter-like digits (4→A; e.g., M4T3R1AL-MATERIAL faster than M8T7R2AL-MATERIAL; see Kinoshita, Robidoux, Mills, Norris, 2013; Perea et al. 2008, for behavioral evidence; see Molinaro, Duñabeitia, Marín-Gutiérrez, Carreiras 2010, for electrophysiological evidence), but also with visually similar letters (i→j; e.g., obiect-OBJECT faster than obaect-OBJECT; Marcet & Perea 2017, 2018a, for behavioral evidence). Indeed, in a recent event-related potential masked priming experiment, Gutiérrez-Sigut, Marcet, and Perea (2019) found that, for a target like OBJETO ([/ob'xeto/] object in English), the visually similar prime obieto behaved exactly as the identity prime objeto in the N250 component, whereas the visually dissimilar prime obaeto produced more negativity. It was at a later lexico-semantic component (N400) when the visually similar prime obieto produced more negativity than the identity prime objeto (Gutiérrez-Sigut et al. 2019).

These visual similarity effects can be readily explained in terms of perceptual noise concerning letter identity in the first moments of processing: stimuli like M4TERIAL or obiect would initially produce a perceptual trace very similar to their base words (see Norris & Kinoshita 2012). The puzzle here is that diacritical vowels are highly visually similar to their non-accented counterparts (see Simpson, Mousikou, Montoya, Defior, 2012) and, hence, even under the assumption that "é" and "e" correspond to different letter units, one would have expected faster responses to féliz-FELIZ (i.e., a visually similar condition) than to fáliz-FELIZ (i.e., a visually dissimilar condition).

The lack of visual similarity with accented vowels in previous research suggests that their diacritical marks (i.e., a visually salient feature) may be the key element here. Importantly, Wiley, Wilson, Rapp (2016) reported that, in a script composed of a number of letters with diacritical marks (Arabic), the most important feature in letter identification is the presence of diacritics. This was the case not only for native speakers of Arabic but also for individuals with no expertise in Arabic. Thus, a hypothesis that explains why a visually similar prime containing a diacritical vowel like féliz is no more effective than its control fáliz at activating the Spanish word FELIZ is that diacritical marks are visually salient features during letter/word processing, thus reducing dramatically any effects of visual similarity.

Indeed, visual similarity effects can be obtained from primes containing non-accented vowels. Perea et al. (2020) found that word recognition times are faster to facil-FÁCIL than to its control fecil-FÁCIL, thus demonstrating that visual similarity effects can be obtained with (non-accented) vowels (i.e., a→Á). Notably, the asymmetry of these visual similarity effects with diacritical vowels (i.e., a→Á but á↛A) has some striking resemblance to early findings on letter recognition and visual search.[2] Tversky (1977) proposed a general theory of asymmetrical similarities in which "asymmetry is explained by the relative salience of the stimuli" (Tversky 1977, p. 337) so that a less salient stimulus is more similar to the more salient stimulus than vice versa. To examine this theory in the context of letter recognition, Tversky (1977) conducted a tachistoschopic same-different experiment in which, for each block, a reference letter (e.g., F) was paired with other letters (e.g., C, E, D; "different" trials) and also with itself ("same" trials). He found that a letter like F was more often misperceived as E (i.e., a letter visually similar to F with an added horizontal bar at the bottom) than the reverse. Converging evidence was also obtained by Treisman and Souther (1985) in the framework of Treisman and Gelade's (1980) feature-integration theory. They found that response times in a visual search task were faster for a target stimulus like Q surrounding by distractors like O than for a target stimulus like O surrounded by distractors

[1] As occurs in other languages, some loan words in English can be written with the original diacritics (e.g., café, naïve).

[2] We thank Steve Lupker for this suggestion.

like Q—they also found the same pattern of effects for other visual objects. Treisman and Souther (1985) concluded that the presence of a salient basic feature makes the stimulus more visually distinctive in the early recognition of letters. Taken together, these theories can be applied to the processing of diacritical marks: diacritical marks would constitute a basic salient primitive feature.

To examine the hypothesis that the lack of a visual similarity effect for accented vowels in previous experiments was due to the special role of diacritical marks during word recognition, we took advantage of the fact that the vowel i in the Latin alphabet contains itself a diacritical mark (i.e., a dot above ı) when presented in lowercase. This dot had originally a diacritical function when originated around the XI century: it helped discriminate the letter i when close to letters like u, n or m (compare *dominium* vs. *domınıum*) (see Sacks 2004).[3] The accent mark on the letter i (i.e., í in Spanish) replaces the superscript dot, and thereby it is less visually salient than in other vowels. Under the assumption that there is perceptual noise in the initial moments of orthographic processing, the dot in "i" and the accent in "í" might be partly confusable. Indeed, the estimated degree of visual similarity between i and í is 6.63 out of 7 in native speakers of Spanish (Simpson et al. 2012).

Thus, one would expect a visually similarity effect when the diacritical mark of the stimulus is not visually salient, as in the case of the letter í. A post hoc analyses on the lexical decision data of Perea et al.'s (2020) Experiment 2 favors this view. When "i" was the critical vowel, there was a visually similarity effect for accented vowels: word identification times to licor-LICOR (liquor in English) and lícor-LICOR were very similar (608 vs. 613 ms, respectively), which in turn were much shorter than those for the visually dissimilar condition lúcor-LICOR (660 ms). In contrast, when the pairs involved the other critical vowels, the identity condition (e.g. feliz-FELIZ) produced faster word identification times (611 ms) than the visually similar and visually dissimilar conditions (féliz-FELIZ and fáliz-FELIZ: 631 and 627 ms, respectively). Although some caution is needed—only 13 of the 90 target words had "i" as the critical letter—these analyses suggest that it is possible to find visual similarity effects with accented vowels.

To test the presence of visual similarly effects with accented vowels, we designed a masked priming experiment in which we added a subtle modification to the i→j manipulation used by Marcet and Perea (2017, 2018a; see also Gutiérrez-Sigut et al. 2019). As indicated earlier, the visually similar prime obieto is much more effective than the visually dissimilar prime obaeto at activating the target word OBJETO in behavioral, eye tracking, and electrophysiological measures (Marcet & Perea, 2017, 2018b; see also Gutiérrez-Sigut et al. 2019). Here, we examined whether the visually similar prime obíeto is also more effective at activating the target word OBJETO than its control obáeto-OBJETO. Specifically, we designed a factorial masked priming experiment manipulating both prime-target visual similarity and the presence/absence of an accented vowel in the prime. For each target word (e.g., OBJETO) we created four pseudoword primes: (1) a visually similar prime created by replacing the consonant j with the accented vowel í (obíeto); (2) a visually dissimilar prime in which we replaced the consonant j with an accented vowel other than í (obáeto); (3) a visually similar prime created by substituting the consonant j with the non-accented vowel i (obieto); and (4) a visually dissimilar prime created by substituting the consonant j with an non-accented vowel other than i (obaeto). This way, we can conjointly analyze the effects of visual similarity for accented and non-accented primes (e.g., obíeto-OBJETO vs. obáeto-OBJETO; obieto-OBJETO vs. obaeto-OBJETO).

The predictions of the present experiment are clear-cut: If there is perceptual noise in the mapping from the visual features onto the letter level during the first stages of visual word recognition—as assumed by leading models of visual word recognition (e.g., Bayesian Reader model: Norris & Kinoshita 2012), one would expect the accented vowel í to be partially confusable with the visually similar letter j. If this is so, one would expect a visual similarity effect not only for non-accented vowel primes (e.g., obieto-OBJETO faster than for obaeto-OBJETO), but also for accented vowel primes (e.g., obíeto-OBJETO faster than for obáeto-OBJETO). This outcome would demonstrate that visual similarity effects can be obtained with accented vowels, thus qualifying the view that accented vowels do not activate their non-accented counterparts (see Chetail & Boursain 2019). Alternatively, if accent marks in vowels—regardless of their idiosyncrasies (i.e., the tittle in letter i)—preclude them from activating their non-accented counterparts in the first moments of visual word recognition, one would expect an effect of visual similarity for the non-accented conditions (i.e., obieto-OBJETO faster than obaeto-OBJETO, replicating earlier experiments), but not for the accented conditions (i.e., similar response times for obíeto-OBJETO and obáeto-OBJETO). This outcome would support Chetail and Boursain's (2019) claim that accented and non-accented vowels would correspond to completely separated units in the word recognition system over and beyond the effects of visual similarity. Finally, our design also allowed us to examine whether the sole presence of an accented vowel in the prime hinders the processing of word stimuli with no accent marks. If this is so, one would expect slower responses for the target words when the primes contain a diacritical vowel—bear in mind that the accented primes obíeto and obáeto contain

[3] The only exception is the Turkish alphabet created after Atatürk's Reforms in 1928, in which there is a dotted i (/i/) and a dotless ı (/ɯ/).

explicit lexical stress information from a vowel that is absent in the target OBJETO.

Methods

Participants

Sixty-four undergraduate students from the University of Valencia took part in the experiment in exchange of course credit or a small gift. All of them were native speakers of Spanish with normal (or corrected-to-normal) vision and no reading difficulties. All participants signed a consent form before the experiment. With this sample size, the number of observations in each priming condition was 2240, which is in line with the recommendation of Brysbaert and Stevens (2018) for masked priming experiments.

Materials

We selected 124 Spanish words from Marcet and Perea's (2017) Experiment 1. All these words contained j as an internal letter and no accented vowels (e.g., the word pájaro [bird] could not be selected). The mean Zipf frequency was 3.67 (range 1.71–5.77), the mean number of letters was 7.6 (range 5–11), and the mean OLD20 was 2.13 (range 1.30–4.25) in the EsPal database (Duchon, Perea, Sebastián-Gallés, Martí, & Carreiras 2013). For each target word, we created four pseudoword primes: (1) a prime created by replacing the letter j with the diacritical vowel í (e.g., obíeto-OBJETO); (2) a prime created by replacing the letter j with the vowel i (e.g., obieto-OBJETO); (3) a prime created by replacing the letter j with a diacritical vowel other than í (e.g., obáeto-OBJETO); and (4) a prime that was visually similar by replacing the letter j with a non-diacritical vowel other than i (e.g., obaeto-OBJETO). We employed 124 orthographically legal nonwords with no diacritical vowels from the Marcet and Perea (2017) experiments—the nonwords always contained the letter j in an internal position. For the nonword targets, we created pseudoword primes with the same manipulation as that for word targets. To counterbalance the prime-target conditions across participants, we created four lists in a Latin-square manner (e.g., obíeto-OBJETO in List 1; obieto-OBJETO in List 2; obáeto-OBJETO in List 3; obaeto-OBJETO in List 4). Sixteen participants received each counterbalancing list. A list of the items is presented in the "Appendix A".

Procedure

The experiment took place in a quiet lab in groups of up to seven participants. The experiment was programmed in DMDX (Forster & Forster 2003). The stimuli were presented with 14-pt Lucida Consolas (i.e., a monospaced font). Each trial began with a pattern mask (a series of #'s; the same as the length of the prime) for 500-ms, followed in the same location by a 50-ms lowercase prime, and then an uppercase target until response—or 2 s had passed. Participants were instructed to press as fast as possible a green button if the letter string was a real Spanish word and to press a red button if the letter string was not a word. They were also instructed to keep the error rate low. Sixteen practice trials preceded by 248-trial experimental phase. There was a short break after the initial 124 trials. The experiment took around 10–12 min.

Table 1 Mean response times and error rates for each of the conditions in the experiment

	Type of prime		
	Visually Similar	Visually Dissimilar	Visual similarity Effect
Words			
Accented prime	642 (3.4)	656 (4.7)	14 (1.3)
Non-accented prime	630 (3.2)	651 (4.0)	21 (0.8)
Nonwords			
Accented prime	831 (9.7)	831 (9.4)	0 (−0.3)
Non-accented prime	833 (10.0)	831 (9.6)	−2 (−0.4)

Results

For the response time (RT) analyses, we excluded both incorrect responses and those correct RTs shorter than 250 ms—note that no RTs could be longer than the 2-s deadline. Table 1 displays the mean RTs and accuracy per condition. We focused on the word trials—note that masked priming effects in lexical decision are usually negligible for nonword trials.

To conduct the inferential analyses, we employed Bayesian linear mixed-effects models using the brms package (Bürkner 2018) in R (R Core Team 2020). The fixed factors were Visual similarity (Similar vs. Dissimilar) and Type of prime (without Diacritics vs. with Diacritics)—each was coded as −0.5 and 0.5. We fitted the model with the maximal random effect structure in terms of by-subjects and by-items intercepts and slopes allowed by our design: Dependent_Variable ~ similarity × accent + (1 + similarity × accent|subject) + (1 + similarity × accent|item). To model the RT data, we used the ex-Gaussian distribution, whereas to model the accuracy data, we used the Bernoulli distribution. For the fits of each model, we employed 4

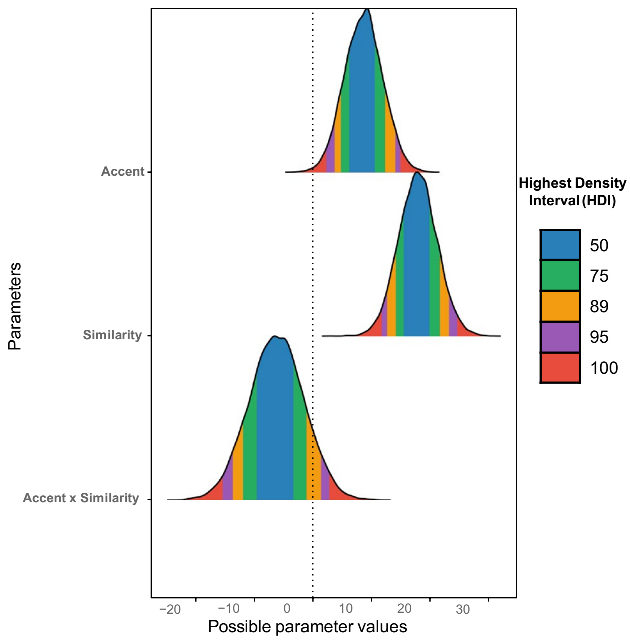

Fig. 1. 50%, 75%, 89%, 95%, and 100% Highest Density Intervals of the posterior distributions for each of the parameters of the model

chains, each with 5000 iterations—there was a warmup of 1000 iterations. The fits for the latency and accuracy data were successful (Rhat = 1.00 for all parameters). For the RT data, the effective sample size (bulk ESS) for the effects of visually similarity, type of prime, and their interaction was 14,975, 15,912, and 14,039, respectively—the code is provided in "Appendix B". For the accuracy data, the effective sample size for the effects of visually similarity, type of prime, and their interaction was 12,146, 10,056, and 12,600, respectively. Effects were considered significant when the 95% credible interval of the posterior distributions would not cross zero (see Fig. 1).

RT data

Response times were faster when the target word was preceded by a visually similar prime than when preceded by a visually dissimilar prime (b = 17.90 ms, 95% Credible Interval [11.48, 24.44]) and when preceded by a non-accented prime than when preceded by an accented prime (b = 8.67 ms, 95% Credible Interval [2.39, 15.01]). The magnitude of the visual similarity effect was slightly greater for the non-accented than for accented primes (21 vs. 14 ms, on average, respectively), but the 95% credible interval of the interaction included zero [− 15.30, 2.90] (see Table 2).

Table 2 Parameter estimates in the latency and accuracy data for word trials using Bayesian linear mixed effects models

	Estimate	SE	95% Credible Interval
Latency data			
Intercept	633.78	9.18	[615.86, 652.24]
Accent	**8.67**	**3.24**	**[2.39, 15.01]**
Similarity	**17.90**	**3.30**	**[11.48, 24.44]**
Accent × similarity	−6.16	4.67	[−15.30, 2.90]
Accuracy data			
Intercept	3.96	0.21	[3.57, 4.39]
Accent	0.10	0.25	[−0.36, 0.61]
Similarity	−0.15	0.22	[−0.58, 0.30]
Accent × similarity	−0.20	0.30	[−0.79, 0.37]

Those parameters with 95% credible intervals beyond 0 are in **bold**

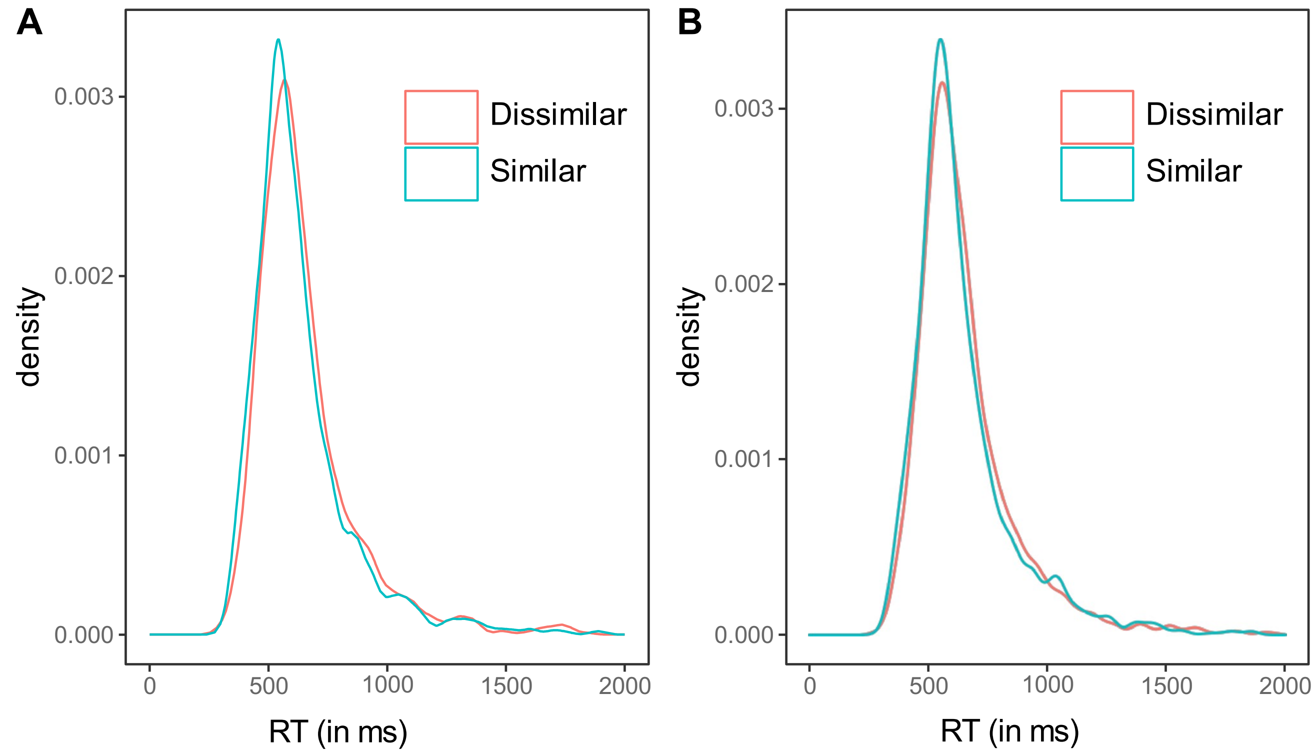

Fig. 2 Density plot of the visually similar vs. visual dissimilar priming conditions for non-accented primes (**a**) and for accented primes (**b**)

Accuracy data

There were no signs of any effects and all estimates were well within the 95% credible intervals—note that accuracy was in the range of 0.95 and 0.96 in all conditions.

To further examine the visual similarity effect on the latency data, we created a density plot for non-accented and accented primes (a, b of Fig. 2). As can be seen in the figure, there is small shift between the distributions of visually similar and dissimilar conditions—this occurred regardless of whether the prime was accented or not. This shift in the RT distributions is the typical pattern in masked priming experiments and suggests that the effect is due to an encoding advantage (see Gomez et al. 2013, for quantitative modeling of encoding vs. decision effects). We also fitted an ex-Gaussian distribution to each condition and participant with the retimes package (Massida 2013) in R. Consistent with Fig. 2, the Bayesian ANOVAs on the centrality parameter *mu* showed an advantage of the visual similar condition over the visually dissimilar ($BF_{10}=9.41$, i.e., the data were 9.41 times more likely under the alternative hypothesis than under the null hypothesis) with no signs of an interaction with type of prime ($BF_{10}=0.22$). Furthermore, consistent with the idea of the visual similarity effect being due to a shift of the RT distributions, we found evidence against an effect of visual similarity effect in the *sigma* or *tau* parameters (*sigma*: $BF_{10}=0.15$; *tau*: $BF_{10}=0.13$).

Discussion

The word recognition system of adult skilled readers is extremely resilient: masked priming effects can be readily obtained even when the briefly and masked stimuli are presented within a noisy background (e.g., CATCHAPs: simple →SIMPLE; Hannagan, Ktori, Chanceaux, & Grainger, 2012), when there are changes of letter order (e.g., transposed-letter effect: jugde→JUDGE; Forster, Davis, Schoknecht, & Carter 1987) and when there are changes in letter identity (e.g., visual similarity effect: M4T3RI4L→MATERIAL; Perea et al. 2008; obiect→OBJECT; Marcet & Perea 2017; docurnent→DOCUMENT; Marcet & Perea 2018a; facil→FÁCIL; Perea et al. 2020).

Somewhat strikingly, previous masked priming experiments did not find visual similarity effects with accented vowels (e.g., jéton-JETON = juton-JETON, Chetail & Boursain 2019; féliz-FELIZ = fáliz-FELIZ, Perea et al. 2020). Here we tested the hypothesis that these null effects were simply due to the saliency of the accent marks (see Tversky 1977, for a general model of asymmetrical similarity in which salient features play a key role). To that end, we examined whether visually similarity effects for accented vowels can occur when their letter base contains a superscript mark (i.e., the dot in the letter i). Using the masked priming paradigm, we designed an experiment manipulating the prime-target visual similarity and the presence/absence of accented vowels in the prime (i.e., obíeto-OBJETO vs. obáeto-OBJETO; obieto-OBJETO vs. obaeto-OBJETO). We found a sizeable visual similarity effect that was similar in magnitude for non-accented vowels (21 ms; e.g., obieto-OBJETO faster than obaeto-OBJETO; Marcet & Perea 2017, 2018a) and accented vowels (14 ms e.g., obíeto-OBJETO faster than obáeto-OBJETO). This visual similarity effect can be interpreted as due to an encoding advantage during word processing, as deduced from the changes in shift in the RT distributions of the visually similar vs. visually dissimilar conditions (see Gomez et al. 2013, for discussion). In addition, our results showed that accented primes hindered the processing of the target words, which were always non-accented (e.g., obieto-OBJETO was processed faster than obíeto-OBJETO)—this detrimental effect can be explained by the mismatching lexical stress information from the accented primes (see Perea et al. 2020, for discussion). Although this effect was numerically larger for the visually similar primes, the interaction was not significant—we prefer to be cautious about over-interpreting these small differences.

Thus, our experiment demonstrated that visual similarity effects can be obtained not only from non-accented vowels (e.g., a→Á; facil→FÁCIL; Perea et al. 2020), but also from accented vowels—at least for vowels that contain a superscript mark such as the vowel i. The visual similarity effect for obíeto-OBJETO in the present experiment suggests that the word recognition system initially interpreted the letter accented letter í in the masked prime obíeto as its visually similar letter j. This finding strongly suggests that the reason why visual similarity effects do not occur for other accented vowels (e.g., féliz-FELIZ is not more effective than fáliz-FALIZ; Chetail & Boursain 2019; Perea et al. 2020) is due to the salience of their accent marks. Critically, this salience would be much reduced for an accented "í" as its non-accented counterpart "i" also contains a diacritical mark. This interpretation fits well with Tversky's (1977) theory of similarities between objects: the less salient object is, the more perceptually similar to the more salient object than vice versa (e.g., the letter F is more similar to the letter E than the reverse).

Critically, in the framework of Tversky's (1977) theory, the accented letter é would have a salient feature that would make it less similar to its non-accented counterpart e than vice versa (e.g., e→é, but é↛e; see also Treisman & Souther 1985, for parallel evidence in object/letter recognition). If this interpretation is correct, this pattern of asymmetric similarities should not be exclusive to vowels, but it would also extend to consonants. Evidence supporting this view was obtained recently by Marcet, Ghukasyan, Fernández-López, and Perea (2020). They examined visual similarity effects using a consonant letter in Spanish that could contain or not a tilde (n pronounced /n/ vs. ñ pronounced /ɲ/]). In a masked priming lexical decision experiment, Marcet et al. found a visual similarity effect from n to ñ (muneca-MUÑECA faster than museca-MUÑECA [doll in English], but not from ñ to n (similar response times for moñeda-MONEDA and moseda- MONEDA [coin in English]). A similar case applies to visual similarity effects with consonants in orthographic systems like Arabic. Perea et al. (2016, 2018) found similar response times to target word like صحفية when it was preceded by a visually similar prime (حـ → خـ; e.g., صخفية) or a visually dissimilar prime (e.g., صكفية).

Further evidence of the role of the salience of the accented letters in masked priming comes from the comparison of the identity condition and the visually similar condition in the Chetail and Boursain (2019) and the Perea et al. (2020) lexical decision experiments. Chetail and Boursain (2019) found a 50 ms advantage of the identity condition, whereas this difference was smaller in the Perea et al. (2020) experiment (17 ms). A reason for this apparent discrepancy in effect sizes is because of the higher visual saliency of the accented primes in the Chetail and Boursain (2019) experiment. The vast majority of the accented vowels in the Chetail and Boursain (2019) experiment contained a circumflex (i.e., â, î, ô, û; 72 out of the 104 words), which is a highly salient visual mark (e.g., compare tâper-TAPER vs. taper-TAPER). In contrast, the accented primes in the Perea et al. (2020) experiment contained a less salient mark (acute accent: á, é, í, ó, ú; e.g., compare fácil-FACIL vs. facil-FACIL). Taken together, all these findings strongly suggest that the salience of the diacritical marks in accented primes makes them less perceptually confusable to their non-accented counterparts.

A remaining issue is whether accented and non-accented vowels share the same abstract units in the word recognition system. The lack of priming from féliz to FELIZ (Chetail & Boursain 2019; Perea et al. 2020) strongly suggests that the é does not activate the same letter representation that e does. Here, we have argued that a reason why the accented prime féliz does not prime FELIZ in comparison to the control prime fáliz is because the accent mark is visually salient in féliz, hence, indicating that the second letter is not an e. That is, the recognition process in masked priming would develop sufficiently to allow it to know that the letter é is not e. Keep in mind that if é and e shared the same representation, it would not matter at all that the second letter is perceived to be an é rather than an e. Either would activate the exact same letter representation and, therefore, féliz would be providing the exact same level of priming that feliz would for the target word FELIZ.

Altogether, these findings suggest that the previous demonstrations of null effects of visual similarity effects with primes containing accented vowels can be explained by the saliency of the diacritical marks. Additional research is necessary to examine whether the location of the diacritical mark (above [á in Spanish]; below [ą in Polish], or across [Ø in Norwegian]) and the type of diacritical mark (e.g. accent [á in Spanish], dot [ä in German], curve [ă in Romanian], macron [ā in Latvian], or ring [å in Norwegian]) may affect how accented vowels are encoded in the early stages of word processing. Additionally, it may also be important to consider whether the phonological characteristics of the accented vowels play a role in this process. Depending on the language, non-accented and accented vowels are considered as different letters (e.g., a→/a/ vs. ä→/æ/ in Finnish) and, furthermore, there are languages like Vietnamese in which vowels may have two diacritical marks: a mark for vowel quality and a mark of tone (as in Tiếng Việt [Vietnamese language]). Finally, these empirical studies with accented vs. non-accented vowels should be complemented with simulation work on computational models of visual word recognition (e.g., the easyNet platform; see Adelman, Davis, & Dubian 2018).

In sum, all European languages other than English contain accented vowels to signal various phonological elements (e.g., vowel quality, vowel length, lexical stress) that cannot be accurately represented by the original Latin script. Recent research has suggested that accented vowels are processed differently from their non-accented counterparts (e.g., á↛A; see Chetail & Boursain 2019). However, this finding cannot be easily reconciled with the existence of visual similarity effects from non-accented vowels (e.g., a→Á; see Perea et al. 2020). We showed that, when minimizing visual saliency using a vowel that by itself contains a diacritical mark (the letter i), accented primes produce a sizeable visual similarity effect (obíeto→OBJETO). Thus, at least for a script like Spanish in which diacritical marks do not signal vowel quality, there is nothing special about the processing of accented vowels when the saliency of the diacritical marks is reduced. Instead, the a→á vs. á↛a asymmetry in a masked priming situation obtained in previous research can be explained in terms of the salience of the diacritical marks in the first moments of processing.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The procedures involving human participants in this study were approved by the Experimental Research Ethics Committee of the Universitat de València and they were in accordance with the Declaration of Helsinki. All participants provided written informed consent before starting the experimental session.

Appendix A

List of stimuli presented in quintuplets: accented visually similar prime; accented visually dissimilar prime, non-accented visually similar prime; non-accented visually; TARGET.

Words: masaie, masaíe, masaoe, masaóe, MASAJE; carcaiada, carcaíada, carcaoada, carcaóada, CARCAJADA; mensaie, mensaíe, mensaoe, mensaóe, MENSAJE; suieto, suíeto, suaeto, suáeto, SUJETO; taiante, taíante, tauante, taúante, TAJANTE; cerraiero, cerraíero, cerraoero, cerraóero, CERRAJERO; enveiecer, enveíecer, enveaecer, enveáecer, ENVEJECER; paiarita, paíarita, paearita, paéarita, PAJARITA; cerroio, cerroío, cerroeo, cerroéo, CERROJO; viaiero, viaíero, viauero, viaúero, VIAJERO; deiar, deíar, deuar, deúar, DEJAR; aieno, aíeno, aoeno, aóeno, AJENO; pareia, pareía, pareoa, pareóa, PAREJA; vieio, vieío, vieao, vieáo, VIEJO; caiero, caíero, cauero, caúero, CAJERO; obietivo, obíetivo, obaetivo, obáetivo, OBJETIVO; dopaie, dopaíe, dopaoe, dopaóe, DOPAJE; nochevieia, nochevieía, nochevieoa, nochevieóa, NOCHEVIEJA; renacuaio, renacuaío, renacuaeo, renacuaéo, RENACUAJO; graniero, granícro, granaero, granáero, GRANJERO; bandeia, bandeía, bandeoa, bandeóa, BANDEJA; maneiar, maneíar, maneuar, maneúar, MANEJAR; subiuntivo, subíuntivo, subauntivo, subáuntivo, SUBJUNTIVO; sonaiero, sonaíero, sonaoero, sonaóero, SONAJERO; rodaie, rodaíe, rodaoe, rodaóe, RODAJE; fichaie, fichaíe, fichaue, fichaúe, FICHAJE; aterrizaie, aterrizaíe, aterrizaoe, aterrizaóe, ATERRIZAJE; coniunto, coníunto, coneunto, conéunto, CONJUNTO; salvaie, salvaíe, salvaoe, salvaóe, SALVAJE; aconseiar, aconseíar, aconseoar, aconseóar, ACONSEJAR; relaiante, relaíante, relaeante, relaéante, RELAJANTE; maquillaie, maquillaíe, maquillaue, maquillaúe, MAQUILLAJE; trabaiador, trabaíador, trabauador, trabaúador, TRABAJADOR; esponia, esponía, esponea, esponéa, ESPONJA; forceiear, forceíear, forceuear, forceúear, FORCEJEAR; narania, naranía, naranea, naranéa, NARANJA; eiercicio, eíercicio, euercicio, eúercicio, EJERCICIO; camuflaie, camuflaíe, camuflaoe, camuflaóe, CAMUFLAJE; personaie, personaíe, personaoe, personaóe, PERSONAJE; conserie, conseríe, conserae, conseráe, CONSERJE; meiorar, meíorar, meaorar, meáorar, MEJORAR; espionaie, espionaíe, espionaue, espionaúe, ESPIONAJE; aiustar, aíustar, aeustar, aéustar, AJUSTAR; debaio, debaío, debaeo, debaéo, DEBAJO; tarieta, taríeta, taraeta, taráeta, TARJETA; compleio, compleío, compleao, compleáo, COMPLEJO; mensaiero, mensaíero, mensauero, mensaúero, MENSAJERO; suietador, suíetador, suoetador, suóetador, SUJETADOR; bereniena, bereníena, berenaena, berenáena, BERENJENA; abeia, abeía, abeua, abeúa, ABEJA; arbitraie, arbitraíe, arbitraue, arbitraúe, ARBITRAJE; montaie, montaíe, montaue, montaúe, MONTAJE; abaio, abaío, abauo, abaúo, ABAJO; azuleio, azuleío, azuleuo, azuleúo, AZULEJO; teiado, teíado, teuado, teúado, TEJADO; iniusticia, iníusticia, ineusticia, inéusticia, INJUSTICIA; extraniero, extraníero, extranaero, extranáero, EXTRANJERO; carruaie, carruaíe, carruaue, carruaúe, CARRUAJE; burbuia, burbuía, burbuea, burbuéa, BURBUJA; vendaie, vendaíe, vendaoe, vendaóe, VENDAJE; chantaie, chantaíe, chantaoe, chantaóe, CHANTAJE; dibuiar, dibuíar, dibuoar, dibuóar, DIBUJAR; adiunto, adíunto, adeunto, adéunto, ADJUNTO; aiusticiar, aíusticiar, aeusticiar, aéusticiar, AJUSTICIAR; potaie, potaíe, potaue, potaúe, POTAJE; bricolaie, bricolaíe, bricolaue, bricolaúe, BRICOLAJE; eiercer, eíercer, eaercer, eáercer, EJERCER; muier, muíer, muaer, muáer, MUJER; coniura, coníura, conoura, conóura, CONJURA; pegaioso, pegaíoso, pegaeoso, pegaéoso, PEGAJOSO; aiedrez, aíedrez, auedrez, aúedrez, AJEDREZ; coneio, coneío, coneuo, coneúo, CONEJO; ciruiano, ciruíano, cirueano, ciruéano, CIRUJANO; reloiero, reloíero, reloaero, reloáero, RELOJERO; floio, floío, floeo, floéo, FLOJO; oveia, oveía, oveua, oveúa, OVEJA; preiuicio, preíuicio, preouicio, preóuicio, PREJUICIO; adietivo, adíetivo, adaetivo, adáetivo, ADJETIVO; infrarroios, infrarroíos, infrarrouos, infrarroúos, INFRARROJOS; rebaia, rebaía, rebaua, rebaúa, REBAJA; sabotaie, sabotaíe, sabotaoe, sabotaóe, SABOTAJE; subietivo, subíetivo, subaetivo, subáetivo, SUBJETIVO; empuiar, empuíar, emopuear, emóúúéáú, EMPUJAR; eiemplo, eíemplo, eaemplo, eáemplo, EJEMPLO; reciclaie, reciclaíe, reciclaue, reciclaúe, RECICLAJE; calleiero, calleíero, calleaero, calleáero, CALLEJERO; porcentaie, porcentaíe, porcentaue, porcentaúe, PORCENTAJE; paisaie, paisaíe, paisaue, paisaúe, PAISAJE; semeiante, semeíante, semeuante, semeúante, SEMEJANTE; maiestad, maíestad, maoestad, maóestad, MAJESTAD; iniurias, iníurias, inaurias, ináurias, INJURIAS; estropaio, estropaío, estropaeo, estropaéo, ESTROPAJO; pelirroio, pelirroío, pelirroao, pelirroáo, PELIRROJO; pasaiero, pasaíero, pasauero, pasaúero, PASAJERO; conseio, conseío, conseao, conseáo, CONSEJO; luiosa, luíosa, lueosa, luéosa, LUJOSA; caniear, caníear, canuear, canúear, CANJEAR; ventaia, ventaía, ventaea, ventaéa, VENTAJA; leiano, leíano, leuano, leúano, LEJANO; espeio, espeío, espeao, espeáo, ESPEJO; moiado, moíado, mouado, moúado, MOJADO; bruia, bruía, bruea, bruéa, BRUJA; obieto, obíeto, obueto, obúeto, OBJETO; equipaie, equipaíe, equipaoe, equipaóe, EQUIPAJE; homenaie, homenaíe, homenaue, homenaúe, HOMENAJE; oieras, oíeras, oueras, oúeras, OJERAS; conceial, conceíal, conceoal, conceóal, CONCEJAL; cangreio, cangreío, cangreao, cangreáo, CANGREJO; embaiador, embaíador, embauador, embaúador, EMBAJADOR; patinaie, patinaíe, patinaue, patinaúe, PATINAJE; garaie, garaíe, garaoe, garaóe, GARAJE; desventaia, desventaía, desventaoa, desventaóa, DESVENTAJA; reportaie, reportaíe, reportaoe, reportaóe, REPORTAJE; tatuaie, tatuaíe, tatuaoe, tatuaóe, TATUAJE; refleio, refleío, refleao, refleáo, REFLEJO; hoialata, hoíalata, hoealata, hoéalata, HOJALATA; lenteias, lenteías, lenteoas, lenteóas, LENTEJAS; lenguaie, lenguaíe, lenguaoe, lenguaóe, LENGUAJE; navaia, navaía, navaea, navaéa, NAVAJA; oruio, oruío, orueo, oruéo, ORUJO; moraleia, moraleía, moraleua, moraleúa, MORALEJA; oreia, oreía, oreua, oreúa, OREJA; eiecutivo, eíecutivo, euecutivo, eúecutivo, EJECUTIVO; hoialdre, hoíaldre, houaldre, hoúaldre, HOJALDRE.

Nonwords: manuie, manuíe, manuoe, manuóe, MANUJE; cosmaieda, cosmaíeda, cosmaoeda, cosmaóeda, COSMAJEDA; ranvaie, ranvaíe, ranvaoe, ranvaóe, RANVAJE; tuiemo, tuíemo, tuaemo, tuáemo, TUJEMO; baiento, baíento, baoento, baóento, BAJENTO; darreiaro, darreíaro, darreoaro, darreóaro, DARREJARO; enmoiener, enmoíener, enmoaener, enmoáener, ENMOJENER; maiacisa, maíacisa, maeacisa, maéacisa, MAJACISA; celloia, celloía, celloea, celloéa, CELLOJA; liaiaro, liaíaro, liauaro, liaúaro, LIAJARO; geiar, geíar, geuar, geúar, GEJAR; eiore, eíore, euore, eúore, EJORE; maceia, maceía, maceoa, maceóa, MACEJA; dieie, dieíe, dieae, dieáe, DIEJE; caiena, caíena, caoena, caóena, CAJENA; osiitilo, osíitilo, osaitilo, osáitilo, OSJITILO; doduie, doduíe, doduoe, doduóe, DODUJE; gochibiuia, gochibiuía, gochibiuoa, gochibiuóa, GOCHIBIUJA; senaleaio, senaleaío, senaleaeo, senaleaéo, SENALEAJO; cleniero, cleníero, clenaero, clenáero, CLENJERO; tenceia, tenceía, tenceoa, tenceóa, TENCEJA; paceiar, paceíar, paceuar, paceúar, PACEJAR; solientido, solíentido, solaentido, soláentido, SOLJENTIDO; momaiera, momaíera, momaoera, momaóera, MOMAJERA; ropuie, ropuíe, ropuoe, ropuóe, ROPUJE; gilloie, gilloíe, gilloue, gilloúe, GILLOJE; acallipaie, acallipaíe, acallipaoe, acallipaóe, ACALLIPAJE; corionto, coríonto, coreonto, coréonto, CORJONTO; sarfaie, sarfaíe, sarfaoe, sarfaóe, SARFAJE; amarseiar, amarseíar, amarseoar, amarseóar, AMARSEJAR; pemaionte, pemaíonte, pemaeonte, pemaéonte, PEMAJONTE; machurraie, machurraíe, machurraue, machurraúe, MACHURRAJE; pramaiadar, pramaíadar, pramauadar, pramaúadar, PRAMAJADAR; escuria, escuría, escurea, escuréa, ESCURJA; bormeiear, bormeíear, bormeuear, bormeúear, BORMEJEAR; lacenia, lacenía, lacenea, lacenéa, LACENJA; eiarsinio, eíarsinio, euarsinio, eúarsinio, EJARSINIO; safudraie, safudraíe, safudraoe, safudraóe, SAFUDRAJE; palmoraie, palmoraíe, palmoraoe, palmoraóe, PALMORAJE; soncirie, sonciríe, soncirae, sonciráe, SONCIRJE; seionar, seíonar, seaonar, seáonar, SEJONAR; esciuraie, esciuraíe, esciuraue, esciuraúe, ESCIURAJE; aiundar, aíundar, aoundar, aóundar, AJUNDAR; detuia, detuía, detuea, detuéa, DETUJA; ponieta, poníeta, ponaeta, ponáeta, PONJETA; colcreio, colcreío, colcreao, colcreáo, COLCREJO; sunvaiemo, sunvaíemo, sunvauemo, sunvaúemo, SUNVAJEMO; muianabor, muíanabor, muoanabor, muóanabor, MUJANABOR; becerieca, beceríeca, beceraeca, beceráeca, BECERJECA; uceio, uceío, uceao, uceáo, UCEJO; angiflaie, angiflaíe, angiflaue, angiflaúe, ANGIFLAJE; penloie, penloíe, penloue, penloúe, PENLOJE; ameio, ameío, ameuo, ameúo, AMEJO; afudeia, afudeía, afudeua, afudeúa, AFUDEJA; beiodo, beíodo, beuodo, beúodo, BEJODO; iniartinia, iníartinia, ineartinia, inéartinia, INJARTINIA; erpreriero, erpreríero, erpreraero, erpreráero, ERPRERJERO; carroeia, carroeía, carroeua, carroeúa, CARROEJA; belmuia, belmuía, belmuea, belmuéa, BELMUJA; landaie, landaíe, landaoe, landaóe, LANDAJE; llentaie, llentaíe, llentaoe, llentaóe, LLENTAJE; sivuier, sivuíer, sivuoer, sivuóer, SIVUJER; etionto, etíonto, eteonto, etéonto, ETJONTO; aiartiniar, aíartiniar, aeartiniar, aéartiniar, AJARTINIAR; mocaie, mocaíe, mocaue, mocaúe, MOCAJE; fritocaie, fritocaíe, fritocaue, fritocaúe, FRITOCAJE; eioscer, eíoscer, eaoscer, eáoscer, EJOSCER; nuior, nuíor, nuaor, nuáor, NUJOR; caliora, calíora, calaora, caláora, CALJORA; mefaioto, mefaíoto, mefaeoto, mefaéoto, MEFAJOTO; aiaclad, aíaclad, auaclad, aúaclad, AJACLAD; coreia, coreía, coreua, coreúa, COREJA; cimuiaca, cimuíaca, cimueaca, cimuéaca, CIMUJACA; pemoiera, pemoíera, pemoaera, pemoáera, PEMOJERA; ploio, ploío, ploeo, ploéo, PLOJO; aceie, aceíe, aceue, aceúe, ACEJE; preiaicia, preíaicia, preoaicia, preóaicia, PREJAICIA; abiotilo, abíotilo, abaotilo, abáotilo, ABJOTILO; istrelleios, istrelleíos, istrelleuos, istrelleúos, ISTRELLEJOS; revoia, revoía, revoea, revoéa, REVOJA; mafonaie, mafonaíe, mafonaoe, mafonaóe, MAFONAJE; molietino, molíetino, molaetino, moláetino, MOLJETINO; egnuiar, egnuíar, egnuear, egnuéar, EGNUJAR; eiuldro, eíuldro, eauldro, eáuldro, EJULDRO; resifraie, resifraíe, resifraue, resifraúe, RESIFRAJE; zachoiera, zachoíera, zachoaera, zachoáera, ZACHOJERA; nompentaie, nompentaíe, nompentaue, nompentaúe, NOMPENTAJE; peimoie, peimoíe, peimoue, peimoúe, PEIMOJE; mecoiante, mecoíante, mecouante, mecoúante, MECOJANTE; paiusdad, paíusdad, paousdad, paóusdad, PAJUSDAD; ilienies, ilíenies, ilaenies, iláenies, ILJENIES; emblataio, emblataío, emblataeo, emblataéo, EMBLATAJO; melilloio, melilloío, melilloao, melilloáo, MELILLOJO; mavaiera, mavaíera, mavauera, mavaúera, MAVAJERA; corceio, corceío, corceao, corceáo, CORCEJO; tuioca, tuíoca, tuaoca, tuáoca, TUJOCA; coriear, coríear, coruear, corúear, CORJEAR; vantuia, vantuía, vantuea, vantuéa, VANTUJA; feiano, feíano, feuano, feúano, FEJANO; anceio, anceío, anceao, anceáo, ANCEJO; poiedo, poíedo, pouedo, poúedo, POJEDO; broio, broío, broeo, broéo, BROJO; utieta, utíeta, utoeta, utóeta, UTJETA; echiluie, echiluíe, echiluoe, echiluóe, ECHILUJE; bosuraie, bosuraíe, bosuraue, bosuraúe, BOSURAJE; oiefos, oíefos, ouefos, oúefos, OJEFOS; calmeial, calmeíal, calmeoal, calmeóal, CALMEJAL; calfreio, calfreío, calfreao, calfreáo, CALFREJO; andeiador, andeíador, andeuador, andeúador, ANDEJADOR; matecaie, matecaíe, matecaue, matecaúe, MATECAJE; faruie, faruíe, faruoe, faruóe, FARUJE; relsantaia, relsantaía, relsantaoa, relsantaóa, RELSANTAJA; redectaie, redectaíe, redectaoe, redectaóe, REDECTAJE; taloeia, taloeía, taloeoa, taloeóa, TALOEJA; detreio, detreío, detreao, detreáo, DETREJO; boiadasa, boíadasa, boeadasa, boéadasa, BOJADASA; fanteies, fanteíes, fanteoes, fanteóes, FANTEJES; vansuaie, vansuaíe, vansuaoe, vansuaóe, VANSUAJE; natuio, natuío, natueo, natuéo, NATUJO; ocuia, ocuía, ocuea, ocuéa, OCUJA; sonaneia, sonaneía, sonaneua, sonaneúa, SONANEJA; oceio, oceío, oceuo, oceúo, OCEJO; aieculisa, aíeculisa, aueculisa, aúeculisa, AJECULISA; hoiectre, hoíectre, houectre, hoúectre, HOJECTRE.

Appendix B (code for the BRMS analyses)

```
nebrija=read.csv("LME64nebrija.csv", header=T, sep=";")
# Analyses on the correct RT data for word targets
byTrial <- nebrija %>%
  filter(lexicality=="WORD") %>%
  filter(RT > 250)
# Mean RTs in each condition
tapply(byTrial$RT,list(byTrial$similarity,
byTrial$accent),mean)
# Convert to factors
byTrial$similarityc=as.factor(byTrial$similarityc)
byTrial$accentc=as.factor(byTrial$accentc)
# RT BRMS model using Ex-Gaussian Distr.
BRMS_TR_NEBRIJA <- brm(data = byTrial, RT ~
accentc*similarityc +

(1+accentc*similarityc|subject) +
(1+accentc*similarityc|item),
                       warmup = 1000,
                       iter = 5000,
                       chains = 4,
                       family = exgaussian(),
                       inits  = "random",
                       control = list(adapt_delta = 0.95),
                               cores  = 4)
# Summary of the model
summary(BRMS_TR_NEBRIJA)
```

References

Adelman, J. S. (2011). Letters in time and retinotopic space. *Psychological Review, 118*, 570–582. https://doi.org/10.1037/a0024811.

Adelman, J. S., Gubian, M., & Davis, C. J. (2018). *easyNet: A computational modeling software package for cognitive science, bridging the gap between novices and experts* [Computer software]. https://adelmanlab.org/easyNet/

Brysbaert, M., & Stevens, M. (2018). Power analysis and effect size in mixed effects models: A tutorial. *Journal of Cognition*. https://doi.org/10.5334/joc.10.

Bürkner, P. (2018). Advanced Bayesian multilevel modeling with the R Package brms. *The R Journal, 10*, 395–411. https://doi.org/10.32614/RJ-2018-017.

Chetail, F., & Boursain, E. (2019). Shared or separated representations for letters with diacritics? *Psychonomic Bulletin & Review, 26*, 347–352. https://doi.org/10.3758/s13423-018-1503-0.

Davis, C. J. (2010). The spatial coding model of visual word identification. *Psychological Review, 117*, 713–758. https://doi.org/10.1037/a0019738.

Dehaene, S., Cohen, L., Sigman, M., & Vinckier, F. (2005). The neural code for written words: A proposal. *Trends in Cognitive Sciences, 9*, 335–341. https://doi.org/10.1016/j.tics.2005.05.004.

Diacritic. In *The Merriam-Webster.com*. https://www.merriam-webster.com/dictionary/diacritic. Accessed 15 Apr 2020

Domínguez, A., & Cuetos, F. (2018). The contrastive value of lexical stress in visual word recognition: Evidence from Spanish. *Psicothema, 30*, 276–282. https://doi.org/10.7334/psicothema2018.30.

Duchon, A., Perea, M., Sebastián-Gallés, N., Martí, A., & Carreiras, M. (2013). EsPal: One-stop shopping for Spanish word properties. *Behavior Research Methods, 45*, 1246–1258. https://doi.org/10.3758/s13428-013-0326-1.

Forster, K. I., & Davis, C. (1984). Repetition priming and frequency attenuation in lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10*, 680–698. https://doi.org/10.1037/0278-7393.10.4.680.

Forster, K. I., Davis, C., Schoknecht, C., & Carter, R. (1987). Masked priming with graphemically related forms: Repetition or partial activation? *Quarterly Journal of Experimental Psychology, 39*, 211–251. https://doi.org/10.1080/14640748708401785.

Forster, K. I., & Forster, J. C. (2003). DMDX: A windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, and Computers, 35*, 116–124. https://doi.org/10.3758/BF03195503.

Gomez, P., Perea, M., & Ratcliff, R. (2013). A diffusion model account of masked versus unmasked priming: Are they qualitatively different? *Journal ofExperimental Psychology: Human Perception and Performance*, *39*(6), 1731–1740. https://doi.org/10.1037/a0032333.

Grainger, J. (2018). Orthographic processing: A "mid-level" vision of reading. *Quarterly Journal of Experimental Psychology, 71*, 335–359. https://doi.org/10.1080/17470218.2017.1314515.

Grainger, J., Rey, A., & Dufau, S. (2008). Letter perception: From pixels to pandemonium. *Trends in Cognitive Sciences, 12*, 381–387. https://doi.org/10.1016/j.tics.2008.06.006.

Gutiérrez-Sigut, E., Marcet, A., & Perea, M. (2019). Tracking the time course of letter visual-similarity effects during word recognition: A masked priming ERP investigation. *Cognitive, Affective, and*

Behavioral Neuroscience, 19, 966–984. https://doi.org/10.3758/s13415-019-00696-1.

Hannagan, T., Ktori, M., Chanceaux, M., & Grainger, J. (2012). Deciphering CAPTCHAs: What a Turing test reveals about human cognition. *PLoS ONE, 7*, e32121. https://doi.org/10.1371/journal.pone.0032121.

Kinoshita, S., Robidoux, S., Mills, L., & Norris, D. (2013). Visual similarity effects on masked priming. *Memory & Cognition, 42*, 821–833. https://doi.org/10.3758/s13421-013-0388-4.

Marcet, A., Ghukasyan, H., Fernández-López, M., & Perea, M. (2020). Jalapeno or Jalapeño: Do diacritics in consonant letters modulate visual similarity effects during word recognition? *Applied Psycholinguistics, 41*, 579–593. https://doi.org/10.1017/S0142716420000090.

Marcet, A., & Perea, M. (2017). Is nevtral NEUTRAL? Visual similarity effects in the early phases of written-word recognition. *Psychonomic Bulletin and Review, 24*, 1180–1185. https://doi.org/10.3758/s13423-016-1180-9.

Marcet, A., & Perea, M. (2018a). Can I order a burger at rnacdonalds.com? Visual similarity effects of multi-letter combinations at the early stages of word recognition. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 44*, 699–706. https://doi.org/10.1037/xlm0000477.

Marcet, A., & Perea, M. (2018b). Visual letter similarity effects during sentence reading: Evidence from the boundary technique. *Acta Psychologica, 190*, 142–149. https://doi.org/10.1016/j.actpsy.2018.08.007.

Massidda, D. (2013). *Retimes: Reaction time analysis*. R package version 0.1-2. https://cran.r-project.org/package=retimes

Merriam-Webster. (2020). Diacritic. *Online dictionary entry*. Retrieved from http://www.merriam-webster.com/dictionary/diacritic.

Molinaro, N., Duñabeitia, J. A., Marín-Gutiérrez, A., & Carreiras, M. (2010). From numbers to letters: Feedback regularization in visual word recognition. *Neuropsychologia, 48*, 1343–1355. https://doi.org/10.1016/j.neuropsychologia.2009.12.037.

Norris, D., & Kinoshita, S. (2012). Reading through a noisy channel: Why there's nothing special about the perception of orthography. *Psychological Review, 119*, 517–545. https://doi.org/10.1037/a0028450.

Perea, M., Abu Mallouh, R., Mohammed, A., Khalifa, B., & Carreiras, M. (2016). Do diacritical marks play a role at the early stages of word recognition in Arabic? *Frontiers in Psychology, 7*, 1255. https://doi.org/10.3389/fpsyg.2016.01255.

Perea, M., Abu Mallouh, R., Mohammed, A., Khalifa, B., & Carreiras, M. (2018). Does visual letter similarity modulate masked form priming in young readers of Arabic? *Journal of Experimental Child Psychology, 169*, 110–117. https://doi.org/10.1016/j.jecp.2017.12.004.

Perea, M., Duñabeitia, J. A., & Carreiras, M. (2008). R34d1ng w0rd5 w1th numb3r5. *Journal of Experimental Psychology: Human Perception and Performance*, *34*(1), 237–241. https://doi.org/10.1037/0096-1523.34.1.237.

Perea, M., Fernández-López, M., & Marcet, A. (2020). What is the letter é? *Scientific Studies of Reading*. https://doi.org/10.1080/10888438.2019.1689570.

R Core Team (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.r-project.org/

Sacks, D. (2004). *Letter perfect: The marvelous history of our alphabet from A to Z*. Portland: Broadway Books.

Simpson, I. C., Mousikou, P., Montoya, J. M., & Defior, S. (2012). A letter visual-similarity matrix for Latin-based alphabets. *Behavior Research Methods, 45*, 431–439. https://doi.org/10.3758/s13428-012-0271-4.

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology, 12*, 97–136. https://doi.org/10.1016/0010-0285(80)90005-5.

Treisman, A., & Souther, J. (1985). Search asymmetry: A diagnostic for preattentive processing of separable features. *Journal of Experimental Psychology: General, 114*, 285–310. https://doi.org/10.1037/0096-3445.114.3.285.

Tversky, A. (1977). Features of similarity. *Psychological Review, 84*, 327–352. https://doi.org/10.1037/0033-295x.84.4.327.

Wells, J. C. (2000). Orthographic diacritics and multilingual computing. *Language Problems and Language Planning, 24*, 249–272. https://doi.org/10.1075/lplp.24.3.04wel.

Wiley, R. W., Wilson, C., & Rapp, B. (2016). The effects of alphabet and expertise on letter perception. *Journal of Experimental Psychology: Human Perception and Performance, 42*, 1186–1203. https://doi.org/10.1037/xhp0000213.