Influence of prime lexicality, frequency and pronounceability on the masked onset priming effect

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Abstract

The present study investigates the origins of the *masked onset priming effect* (MOPE). There are two alternative interpretations that account for most of the evidence reported on the MOPE, so far. The Speech Planning account (SP) identifies the locus of the MOPE in the preparation of the speech response. In contrast, the dual-route theory proposes that the effect arises as a result of the processing of the prime by the nonlexical route. In a series of masked onset priming word naming experiments we test the validity of these accounts by manipulating the primes' frequency, their lexical status and pronounceability. We found consistent MOPEs of similar magnitude with high and low frequency prime words as well as with pronounceable nonwords. Contrarily, when primes consisted of unpronounceable consonantal strings the effect disappeared, suggesting that pronounceability of the prime is a prerequisite for the emergence of the MOPE. These results are in accordance with the predictions of the SP account. The pattern of effects obtained in the present study further defines the origins of the MOPE.

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Influence of prime lexicality, frequency and pronounceability on the masked onset priming effect

Forster and Davis (1991) were the first to identify the *masked onset priming effect* (known as the MOPE). Target items (e.g., *SINK*) are named faster when they are briefly preceded by a masked prime that shares the initial phoneme (e.g., *save*) compared to when it does not (e.g., *farm*). The MOPE has received extensive empirical support (e.g., Carreiras, Ferrand, Grainger, & Perea, 2005; Kinoshita, 2000; Schiller, 2007), and efforts have been dedicated to establish its origins. The different proposals that have tried to account for this effect have mainly focused on the properties of the targets that were responsible for the appearance or the vanishing of the MOPE (e.g., Forster & Davis, 1991; Kinoshita & Woollams, 2002). However, increasing amount of evidence suggests that the nature and the characteristics of the prime are crucial for the emergence of masked priming effects (e.g., Andrews, 1996; Berent & Perfetti, 1995; Bowers, Vigliocco, & Haan, 1998; Duñabeitia, Molinaro, Laka, Estévez, & Carreiras, 2009; Duñabeitia, Perea, & Carreiras, 2009; Perea & Rosa, 2002).

One of the most prominent accounts of the MOPE is based on the dual-route theory and its computationally implemented version, the *Dual Route Cascaded* (DRC) model of reading aloud (e.g., Coltheart, 1978; Coltheart, Rastle, Perry, Langdon & Ziegler, 2001; Forster & Chambers, 1973; see also Biedermann, Coltheart, Nickels, & Saunders, 2009; Mousikou, Coltheart, Finkbeiner, & Saunders, 2009; Mousikou, Coltheart, Saunders, & Yen, in press; Mousikou, Coltheart & Saunders, in press, for updated versions of the DRC model).The dual-route theory proposes that phonology can be computed from orthography through two routes: a fast-acting lexical (or direct) and a slower nonlexical (or indirect) route. Through the lexical route the phonology of the entire word is rapidly retrieved as a whole and it is identified within the phonological lexicon. In contrast, the nonlexical route computes phonology serially in a left-to-right manner through the application of grapheme-to-phoneme conversion rules (GPCs). According to the dual-route theory *"construction of the nonlexical response to the prime operates in a strict left-to-right manner (...), so that by the time the target is presented, the articulation of just the onset of the prime has been planned"* (Forster & Davis, 1991, p. 19). Hence, when primes and targets share their initial phoneme (e.g., *save-SINK*) the output corresponding to the application of the GPC on the initial letter of the primes and the targets will coincide, leading to the observed facilitation in naming the target (see Coltheart et al., 2001; Mousikou et al., 2009; Mousikou, Coltheart, Saunders et al., in press; Mousikou, Coltheart & Saunders, in press for successful simulations of the MOPE with the DRC model). According to the latest version of the model, the effect is further potentiated by the conflict caused by the mismatch between the initial phoneme of the phonologically unrelated prime and the target, as was initially proposed by Forster and Davis (1991; e.g., *farm-SINK*; see also Mousikou et al., 2009; Mousikou, Coltheart, Saunders, in press).

In their seminal study, Forster and Davis (1991), who for the first time put forward the dual-route account of the MOPE, obtained significant MOPEs for low frequency and low density target words as well as for nonword targets, but did not find any effect for high density, high frequency and irregular target words preceded by onset-related primes. In order to explain this pattern of results, Forster and Davis proposed that the nonlexical route was not involved in the recognition of high frequency, high density and irregular words (i.e., a selective shutting down of the nonlexical route). However, in contrast to what Forster and Davis found, significant and comparable MOPEs have been recently obtained for both high and low frequency word targets (Malouf & Kinoshita, 2007). Furthermore, Schiller (2008) reported significant MOPEs using pictures as targets. Schiller's finding is in clear contradiction to Forster and Davis' account, since picture naming inevitably implies the activation of the lexical representation of the displayed item and consequently any observed effects would be the result of the activation of the lexical route. Thus, the assumption of a selective deactivation of the nonlexical route does not seem to be granted by empirical findings. Contrarily, the dual-route theory proposes that both routes are always active during word reading and that their outputs are integrated into a single common set of phonemes (e.g., Coltheart et al., 2001; Mousikou, Coltheart, & Saunders, in press). Hence, the findings obtained by Malouf and Kinoshita and by Schiller are correctly accounted for by the dual-route account of the MOPE. (Even though Forster and Davis' account relies on a dual-route framework, it should be noted that the selective shutting down of the nonlexical route that they proposed is not endorsed by the dual-route theory; see Mousikou, Coltheart, & Saunders, in press for further discussion).

Another central point of the dual-route account of the MOPE is the ascription of the effect to the overlap between the initial letter/phoneme of the prime and that of the target (Coltheart et al., 2001; Mousikou, Coltheart, Saunders et al., in press). Specifically, they suggest that "*for briefly presented primes, only the first letter of the stimulus has been processed by the nonlexical GPC procedure at the point at which the target word is presented*" (Coltheart et al., 2001, p. 226). This assumption was motivated by the finding reported by Kinoshita (2000, Experiment 1). Kinoshita found significant MOPEs with nonword prime-target pairs irrespectively of whether they overlapped in their first or in their first and second letters/phonemes (e.g., *suf-SIB* vs. *mof-SIB* and *sif-SIB* vs. *mof-SIB*). Similarly, Schiller (2004) found similar MOPEs for primes with simple onsets and targets with simple and complex onsets (e.g., *b%%%%%-BALLET* vs. *b%%%%%%-BROEDER*), supporting the assumption of the initial letter being the critical unit. Mousikou, Coltheart, Saunders et al. (in press) have recently replicated Schiller's finding of a significant MOPE with targets with complex onsets, with both word and nonword prime-target pairs (e.g., *biln-BREV* and *disc-DRUM*). Importantly, the authors further extended this finding by manipulating the prime's onset complexity (e.g., *brev-BILN* and *drum-DISC*; but see Kinoshita, 2000, Experiment 2). These results are in accordance with the account of the MOPE offered by the dual-route theory, which proposes that under masked priming conditions only the initial letter/phoneme of the prime gets processed by the nonlexical route (e.g., Coltheart et al., 2001; but see Andrews, 1996; Carreiras et al., 2005; Horemans & Schiller, 2004; Masson & Isaak, 1999; Schiller, 1998 for evidence of effective processing beyond the prime's first letter) [1]. Hence, the dual-route theory predicts that *as long as the initial letter/phoneme is common between prime and target, a MOPE should appear irrespectively of the following graphemes/phonemes of the letter string.*

An interpretation of the MOPE, different from that offered by the dual-route theory, has been put forward by the *Speech Planning* account (SP account, hereafter; Kinoshita, 2000; 2003; Kinoshita & Woollams, 2002; Malouf & Kinoshita, 2007; see also Grainger & Ferrand, 1996; Schiller, 2004; 2007; 2008 for supporting evidence). According to the SP account, the effect has its origin "*in the segment-to-frame association process that occurs further downstream from the frequency-sensitive lexical access process*" (Malouf & Kinoshita, 2007, p. 1164). The idea that the MOPE is closely related to the speech response is supported by the fact that the effect disappears when the task at hand does not involve an overt speech response (e.g., a lexical decision task; see Carreiras et al., 2005; Grainger & Ferrand, 1996). According to the SP account, the serial nature of the MOPE reflects the fact that later phonemic segments cannot be prepared for utterance until the initial ones are selected (Meyer, 1991). The SP account proposes that in a masked priming reading aloud task, participants process the prime up to when its phonological segments are prepared to be uttered. The mismatch between the initial phonemic segments of the onset-unrelated prime-target pairs would thus delay target naming (e.g., Kinoshita, 2003; Malouf & Kinoshita, 2007). By localizing the origins of the MOPE at the speech preparation process, the SP account assumes that the MOPE should not be affected by manipulations at the lexical level (e.g., frequency, lexicality) of the primes/targets (e.g., Kinoshita & Woollams, 2002; Malouf & Kinoshita, 2007).

As described above, the dual-route account of the MOPE supports the idea that this effect originates at the orthography-to-phonology mapping of the prime, while the SP account supports the idea that the effect originates at the segment-to-frame association process. The present study aims at shedding light on the origins of the MOPE by presenting a series of masked priming reading aloud experiments including manipulations carried out exclusively on the primes. First, we examined the influence of the lexical status (words vs. nonwords) and the lexical frequency (high frequency words vs. low frequency words) of the primes. As seen, the dual-route account localizes the MOPE at the nonlexical processing of the primes. Still, within the MOPE literature the manipulations related to the computation of phonology from orthography have so far mainly involved the targets. The word frequency manipulations by Forster and Davis (1991) and by Malouf and Kinoshita (2007) were both carried out exclusively on the targets, while the repeatedly reported lexicality manipulations have always been carried out simultaneously on both primes and targets (e.g., Forster & Davis, 1991; Kinoshita, 2000; Mousikou, Coltheart, & Saunders, in press; Mousikou, Coltheart, Saunders et al., in press). Importantly, in a recent simulation of the MOPE with the DRC model using

Forster and Davis' (1991, Experiment 1) materials, it has been shown that the effect vanished for some very frequent primes (Mousikou, Coltheart, & Saunders, in press) [2]. Mousikou and colleagues proposed that this was due to the sensitivity of the DRC model to the frequency of the primes and they argued that these high frequency primes rapidly activated their orthographic representations through the lexical route. As a consequence, this would lead to enhanced competition at the orthographic lexicon between primes and targets, eliminating any potential benefit arising from the overlapping onsets. This recent simulation shows that the DRC model predicts the absence of MOPE for high-frequency primes, which activate conflicting phonology beyond the onset for the whole string. However, to date there is no available empirical evidence from human data directly examining whether the MOPE is influenced by differences in the activation of the lexical route induced by prime frequency manipulations. Accordingly, the first two experiments aimed at examining whether the MOPE would differ for a group of high frequency Spanish prime words, as compared to low frequency prime words and nonword primes. Following the interpretation of the dual-route theory, given that the effect is solely dependent on the nonlexical activation of the prime which takes place in the same way for high frequency, low frequency and nonword masked primes, significant and comparable MOPEs should be obtained in all the onset-related conditions. However, a modulation of the MOPE by the frequency or the lexicality of the primes would suggest that the lexical route does also play a role in the appearance of this effect (see Mousikou, Coltheart, & Saunders, in press). Moreover, if the lexical route is also activated by the presentation of a masked prime, differences between high and low frequency words and nonwords could be expected, since according to the dual-route theory, the lexical route gets rapidly activated for frequent targets, less rapidly for low frequency targets and even less for nonword targets (Coltheart et al., 2001).

In Experiments 3 and 4 we explored a more constraining prediction derived from the dual-route account and the SP account: the influence of the pronounceability of the primes on the MOPE. The SP account predicts that for a MOPE to appear the primes should be pronounceable. However, for the dual-route account this is not a prerequisite. This discrepancy is of capital importance for a better understanding of the origins of the MOPE. In order to shed light on this issue, in Experiments 3 and 4 we manipulated the pronounceability of the primes (see Table 1 for an overview of the manipulations included in Experiments 1-4). According to the SP account, there should not be any benefit for targets preceded by unpronounceable consonantal primes, irrespectively of whether they share their initial letter/phoneme with the targets, while significant MOPEs should be found for targets preceded by pronounceable onset-related masked primes. Conversely, from the dual-route theory's perspective, manipulating the pronounceability of the prime should not influence the appearance of the MOPE, given that under masked priming conditions only the initial letter/phoneme of the prime can be processed by the nonlexical route. Hence, given that the two available accounts of the MOPE make opposing predictions regarding the influence of the pronounceability of the primes, results from Experiments 3 and 4 will help to a better understanding of the origins of the effect.

(Insert Table 1 around here)

Experiment 1: High frequency, low frequency and nonword primes

Method

Participants. 36 native Spanish speakers completed the experiment. They were all undergraduate students from the University of La Laguna (Spain) participating in the experiment in exchange for course credit.

Materials. A set of 150 Spanish words were used as targets (taken from Sebastián-Gallés, Martí, Carreiras & Cuetos, 2000). Each target (e.g., *CURVA*, the Spanish word for *curve*) could be preceded by i) a high frequency word that shared with it its initial phoneme (e.g., *campo*, the Spanish word for *country*), ii) by a high frequency word phonologically unrelated to the target (e.g., *fondo*, the Spanish word for *bottom*), iii) by a low frequency word that shared the initial phoneme with the target (e.g., *cañón*, the Spanish word for *canon*), iv) by a low frequency word phonologically unrelated to the target (e.g., *belén*, the Spanish word for *crib*), v) by a nonword that shared with it its initial phoneme (e.g., *coslo*) or vi) by a nonword phonologically unrelated to the target (e.g., *foslo;* see Appendix A for a full listing of the materials used). Targets and primes were closely matched for length (measured in number of letters and phonemes), number of syllables and number of orthographic neighbours (*N*; see Table 2 for a full description of the materials used).Considering previous evidence, all the words and nonwords used in the experiment started by a CV letter cluster so that the overlap between related prime and targets only occurred for the initial singleton (see Kinoshita, 2000). Primes and targets were not otherwise related to each other. Six lists of materials were created, so that each target word appeared only once in each list, but each time in a different priming condition. Six different participants were randomly assigned to each of the lists.

(Insert Table 2 around here)

Procedure. Participants were tested individually in a quiet, well-lit room. Presentation of the stimuli and recording of verbal responses were controlled by the DMDX software (Forster & Forster, 2003). The experimental trials began with the centered presentation of a forward mask of hash marks (#), followed by a 50 ms presentation of the lowercase prime and the immediate appearance of the uppercase target. The target stimulus was displayed until a vocal response was given, or for a maximum of 2000 ms. Participants were trained with a 6-item practice to read aloud the words that were displayed on the screen. Reading times were measured from the display of the words to the voice onset. Each participant received a different order of trials.

Results and Discussion

Resulting data were corrected with the help of CheckVocal (Protopapas, 2007). Each voice recording corresponding to the naming of each target was individually explored in order to cross-validate DMDX's marker of voice onset and correctness. Incorrect responses (1.13% of the data) and reaction times below or above 2 standard deviations from the mean (less than 2.3% of the data) were excluded from the latency analysis. The mean latencies for correct responses and error rates are presented in Table 3. ANOVAs for the response latencies and percentages of error were conducted based on a 3 (Type of prime: high frequency word, low frequency word, nonword) x 2 (Relatedness: related, unrelated) x 6 (List: list 1, list 2, list 3, list 4, list 5, list 6) design. In all statistical analyses, the factor List was included as a dummy variable to extract the error variance due to counterbalancing (Pollatsek & Well, 1995).

(Insert Table 3 around here)

Naming latencies were significantly faster for related prime-target pairs than for unrelated pairs (a 10ms difference), $F_1(1, 30)=17.94$, $MSE=285$, $p<.001$; $F_2(1, 144)=33.93$, $MSE=586$, $p<.001$. The effect of Type of prime was not significant (both Fs<1.8 and ps>.16). The interaction between the two main factors was not significant (both Fs<1.9 and ps>.28), showing that the masked onset priming effect was similar for both the high and low frequency prime words as well as for the nonwords (effects of 9, 13 and 7ms, respectively). The simple contrasts were performed in order to examine whether there were significant MOPEs for each of the onset-related priming conditions as compared to their corresponding unrelated controls. Importantly, the simple contrasts showed that participants named the target words significantly faster when they were preceded by each of the three onset-related primes as compared to their corresponding phonemically unrelated control primes (i.e., high frequency: $F_1(1, 30)=6.51$, $MSE=229$, $p<.05$; $F_2(1, 144)=13.21$, $MSE=676$, $p<.001$; low frequency: $F_1(1, 30)=8.20$, $MSE=369$, $p<.01$; $F_2(1, 144)=14.58$, $MSE=793$, $p<.001$; nonwords: $F_1(1, 30)=5.79$, $MSE=158$, $p<.05$; $F_2(1, 144)=1.74$, $MSE=1018$, $p=.19$) [3].

No significant effects were found in the error rate analyses (all Fs<1.7, all ps>.20).

Experiment 1 revealed masked onset priming effects of comparable magnitude for the three types of onset-related primes as compared to their corresponding unrelated control primes (i.e., MOPEs of 9, 13 and 7 ms, for high frequency, low frequency and nonword primes, respectively). To our knowledge, this is the first time such lexical manipulations have been exclusively focused on the primes, where the dual-route theory actually situates the origins of the MOPE. This pattern of effects shows that the MOPE is not dependent on lexical variables of the primes, such as word frequency or lexical status. These results are in line with the dual-route interpretation of the MOPE according to which the effect is exclusively dependent on the processing of the initial letter/phoneme of the prime by the nonlexical route, and thus, it should not be sensitive to manipulations tapping on the activation of the lexical route by the primes (Coltheart et al., 2001). This pattern of effects is also in line with the SP account offered by Kinoshita and colleagues, following a very different rationale (e.g., Kinoshita & Woollams, 2002; Malouf & Kinoshita, 2007). The SP account predicts that manipulations affecting the computation of the prime's frequency or lexicality should not lead to any modulation of the MOPE, since the effect arises at the subsequent stage of the preparation of the speech response. Importantly, these findings are in contrast to the results of a recent simulation study of the MOPE with the DRC model, in which there was not any significant effect for high frequency primes (Mousikou, Coltheart, & Saunders, in press).

Even though at the theoretical level the account of the MOPE offered by the dual-route theory predicts the pattern of results we obtained, the outcome of the simulation by Mousikou, Coltheart and Saunders (in press) contrasts sharply with our results. In Experiment 2 we wanted to revisit this issue, in order to determine whether the extent of the involvement of the lexical route in the appearance of the MOPE offered by the dual-route theory needs to be further defined, or whether the specific parameter setting used in the simulation at stake could have been responsible for the vanishing of the MOPE for the high frequency primes. In Experiment 2 we restricted the number of priming conditions and only included the most relevant ones in order to determine whether lexical frequency/status influences the MOPE. Participants were presented with a new target set preceded by onset-related and unrelated high frequency word primes and nonword primes. The high frequency masked primes vs. nonword masked primes contrast should uncover any potential influence of the distinct involvement of the lexical route, since nonwords are clearly processed through the nonlexical route, while high frequency words could be also processed by the lexical route (according to the recent simulation by Mousikou, Coltheart and Saunders , in press).

Experiment 2: High frequency word primes and nonword primes

Method

Participants. A different group of 32 Spanish native speakers took part in this Experiment. Participants were undergraduate students from the University of La Laguna who completed the experiment for course credit.

Materials. A set of 100 Spanish words were used as targets (e.g., *<u>N</u>IÑA*, the Spanish word for *girl*). Each of these target words could be preceded i) by a high frequency word that shared with it the initial phoneme (e.g., *<u>n</u>oche*, the Spanish word for *night*), ii) by a high frequency word phonologically unrelated to the target (e.g., *<u>c</u>alor*, the Spanish word for *heat*), iii) by a pronounceable nonword that shared with it the initial phoneme (e.g., *<u>n</u>ople*), or iv) by a pronounceable nonword phonologically unrelated to the target (e.g., *<u>c</u>azol*; see Appendix B for a full listing of the materials used). As in Experiment 1, length (measured in number of letters and phonemes), number of syllables and *N* were controlled for across the different conditions (see Table 4 for a full description of the materials used). Moreover, all the items used started by a CV letter cluster, while primes and targets were not semantically related to each other. Four lists of materials were created, so that each target word appeared only once in each list. Priming conditions were counterbalanced across lists. Eight different participants were randomly assigned to each of the lists.

Procedure. The procedure followed was exactly the same as in Experiment 1.

(Insert Table 4 around here)

Results and Discussion

Incorrect responses (less than 0.5% of the data) and reaction times below or above 2 standard deviations from the mean (less than 2.5% of the data) were excluded from the latency analysis. The mean latencies for correct responses and error rates are presented in Table 5. ANOVAs for the response latencies and percentages of error were conducted based on a 2 (Type of prime: high frequency word, nonword) x 2 (Relatedness: related, unrelated) x 4 (List: list 1, list 2, list 3, list 4) design.

(Insert Table 5 around here)

Naming latencies were significantly faster for onset-related prime-target pairs than for unrelated pairs (a 14ms difference), $F_1(1, 28)=42.87$, $MSE=154$, $p<.001$; $F_2(1, 96)=10.99$, $MSE=1849$, $p<.01$. The effect of Type of prime was not significant (both Fs<1.78 and ps>.19). The interaction between the two main factors was not significant, showing that the masked onset priming effect was similar for both the high frequency word primes and for the nonwords (effects of 12 and 16ms, respectively; both $Fs<1$).

Like in Experiment 1, the simple contrasts were performed in order to further explore the statistical reliability of the numerical differences between the different onset-related conditions. Simple contrasts showed that both effects were significant (i.e., high frequency primes: $F_1(1, 28)=18.50$, $MSE=142$, $p<.001$; $F_2(1, 96)=6.90$, $MSE=1227$, $p<.05$; nonword primes: $F_1(1, 28)=26.08$, $MSE=156$, $p<.001$; $F_2(1, 96)=9.81$, $MSE=1226$, $p<.01$).

No significant effects were found in the error rate analyses.

The aim of Experiment 2 was to further confirm the results of Experiment 1 and to disregard any influence of the prime's lexical activation on the MOPE with a more powerful experimental design. The results obtained in Experiment 2 were clear-cut: MOPEs of similar magnitude (12 and 16 ms) appeared with both types of onset-related primes (i.e., high frequency word primes and nonword primes, respectively) as compared to their corresponding unrelated controls. This pattern of effects replicated that obtained in Experiment 1. The fact that the MOPE was significant and comparable in magnitude for both high frequency and nonword primes is in line with the dual-route account and with the SP account of the MOPE, since according to both proposals, the speed of activation of the lexical route by the primes should not affect the MOPE (e.g., Kinoshita, 2003; Mousikou, Coltheart, & Saunders, in press). However, these results are in clear contrast to the recent simulation study by Mousikou et al. (in press), who failed to obtain a significant MOPE for high frequency primes. In line with Mousikou et al.'s proposal, these results suggest that the DRC model should be modified in order to eliminate the influence of the prime's lexical activation on the MOPE.

As seen, the results of Experiments 1 and 2 are in accordance with the predictions of the two available accounts of the MOPE. Hence, the question of whether the MOPE arises as a result of the print-to-sound conversion or as a result of the planning of the speech response remains open. In an effort to adjudicate between the two accounts of the effect, in Experiments 3 and 4 we manipulated the pronounceability of the primes, by using primes that either follow or not graphotactic rules (i.e., words and nonwords vs. unpronounceable consonantal strings). Crucially, the SP account and the dual-route theory make antithetic predictions regarding the influence of the prime's pronounceability on the MOPE. From the SP account's side, given that the MOPE originates at the planning of the speech response, the effect should arise only when this process can effectively proceed (at least for the phonological onset of both primes and targets). However, if either the prime or the target cannot be prepared for overt production, then there should not appear any significant MOPE, irrespectively of whether primes and targets share their initial letter/phoneme. On the other hand, according to the interpretation of the MOPE offered by the dual-route theory, the effect should arise irrespectively of whether the primes are pronounceable or not, given that the only critical factor for the effect to arise should be the match/mismatch between the prime's and the target's initial letter/phoneme (see Mousikou, Coltheart, Saunders et al., in press): For briefly presented masked primes the dual-route theory proposes that the slow operation of the nonlexical route cannot proceed beyond that point (Coltheart et al., 2001).

Recently, Seidenberg, Zevin, Sibley, Woolams and Plaut (2009) have examined whether pronounceabililty influences the reading aloud process. The authors found that participants have greater difficulty in naming nonwords containing graphotactically illegal sequences of letters (e.g., *JULBZ*) as compared to graphotactically legal nonwords containing digraphs (i.e., multi-letter graphemes that map onto a single phoneme; e.g., the *ee* in *NEESH*). These findings suggest that pronounceability is a key factor that might determine human naming latencies, with pronounceable nonwords being produced significantly faster than unpronounceable nonwords. Interestingly, when the authors presented the DRC model with the same set of items, the model produced exactly the opposite behaviour: graphotactically illegal nonwords were read aloud faster than legal nonwords (e.g., *JULBZ* vs. *NEESH*). According to the authors, this was because the nonlexical route of the DRC model processes graphotactically illegal letter strings as if they were graphotactically legal, since the GPCs are in both cases applied sequentially from left to right (letter-by-letter). In contrast, the DRC model has difficulties in processing irregular (but graphotactically legal) nonwords. In essence, these results highlight the fact that the dual-route theory, as well as the DRC model, does not take into account the pronounceability of the string. Hence, considering that whether or not the prime can be uttered (i.e., is pronounceable) is a key factor for the MOPE to arise according to the SP account, while from the dual-route's perspective it should be completely irrelevant, effects of a manipulation on the prime's pronounceability would provide evidence in favor of one account and against the other.

Experiment 3 aims to examine the influence of the pronounceability of the prime on the MOPE. The same Spanish words as in Experiment 1 were used as targets, briefly preceded by onset-related or unrelated masked primes that were high frequency words, nonwords or unpronounceable consonantal strings. To our knowledge, all the primes that have been previously used in the MOPE literature have been pronounceable (existing words or pronounceable nonwords), with the only exception being the study reported by Schiller (2004). The author found significant MOPEs for onset-related primes consisting of a single letter and followed by percent signs (e.g., *b%%%%%-BALLET*) as compared to control primes entirely made of percent signs (e.g., *%%%%%%-BALLET;* see also Schiller, 2008 for a similar procedure with picture targets). Despite the fact that the primes used by Schiller (2004, 2008) were not pronounceable, a direct comparison of his studies to the present pronounceability manipulation cannot be carried out due to the use of percent signs. The processing of Schiller's primes could have been fundamentally different to that of unpronounceable letter primes (see, for instance, Finkbeiner, Almeida, & Caramazza, 2006). Even though symbol strings (or substrings) are not pronounceable in essence, the mismatch created between unrelated letter primes and targets and between symbol primes and targets is not comparable. The use of control primes consisting of percent signs (e.g., %%%%%%) does not lead to the interference effect typically produced by the mismatching onset of letter control primes (see Grainger & Ferrand, 1996; Mousikou, Coltheart, Saunders et al., in press). Moreover, it is not clear to which extent grapheme-to-phoneme conversion rules could be applied to symbols. Thus, even though Schiller (2004, 2008) obtained significant MOPEs for single-letter onset-related primes such a result does not warrant that the pronounceability of the primes will not influence the MOPE.

In Experiment 3 we explored the influence of the pronouceability of the prime by including pronounceable high frequency words and nonwords as primes (e.g., the Spanish word *campo*, meaning *country* in Spanish, and the nonword *comlo* as onset-related primes for the Spanish target *CURVA*, meaning *curve*), as well as unpronounceable consonantal onset-related primes (e.g., *cxrwq*). According to the SP account, no MOPE would be expected for the unpronounceable consonantal strings despite the initial-letter match between primes and targets, since they would not be effectively prepared for utterance. Contrarily, the dual-route theory would predict that a significant effect should emerge irrespectively of whether the onset-related primes were pronounceable or unpronounceable, since according to this framework the only prerequisite for the MOPE to appear is the match in the initial letter/phoneme between prime and target (e.g., Coltheart, Mousikou, Coltheart, Saunders et al., in press).

Experiment 3: High frequency, nonword and unpronounceable consonantal primes

Method

Participants. A different group of 30 Spanish native speakers took part in this Experiment. Participants were undergraduate students from the University of La Laguna who completed the experiment for course credit.

Materials. 150 targets were used in this experiment. Target words, high frequency word primes and pronounceable nonword primes were the same as in Experiment 1. A set of 300 unpronounceable consonantal strings was also created for the purposes of this experiment. Target words (e.g., *CURVA*, the Spanish for *curve*) could be preceded i) by a high frequency word that shared with the target its initial phoneme (e.g., *campo*, the Spanish for *country*), ii) by a high frequency word phonologically unrelated to the target (e.g., *fondo*, the Spanish for *bottom*), iii) by a nonword that shared with the target its initial phoneme (e.g., *comlo*), iv) by a nonword phonologically unrelated to the target (e.g., *foslo*), v) by an unpronounceable consonantal string that shared with the target its initial phoneme (e.g., *cxrwq*), or vi) by an unpronounceable consonantal string phonologically unrelated to the target (e.g., *fxrwq;* see Appendix A for a full listing of the materials used). Six lists of materials were created, so that each target word appeared only once in each list. Priming conditions were counterbalanced across lists. Five different participants were randomly assigned to each of the lists.

Procedure. The procedure followed was exactly the same as in the previous experiments.

Results and Discussion

Incorrect responses (less than 1% of the data) and reaction times below or above 2 standard deviations from the mean (less than 2.7% of the data) were excluded from the latency analysis. The mean latencies for correct responses and error rates are presented in Table 6. ANOVAs for the response latencies and percentages of error were conducted based on a 3 (Type of prime: high frequency word, nonword, unpronounceable consonantal string) x 2 (Relatedness: related, unrelated) x 6 (List: list 1, list 2, list 3, list 4, list 5, list 6) design.

(Insert Table 6 around here)

Naming latencies were significantly faster for related prime-target pairs than for unrelated pairs (an 8 ms difference), $F_1(1, 24)=13.52$, $MSE=212$, $p<.01$; $F_2(1, 144)=10.99$, $MSE=928$, $p<.05$. The effect of Type of prime was not significant, $F_1<1.5$, $p>.25$; $F_2<1$. Crucially, the interaction between the two main factors was significant, $F_1(2, 48)=3.36$, $MSE=133$, $p<.05$; $F_2(2, 288)=3.61$, $MSE=1140$, $p<.05$. The pairwise comparisons performed showed that participants named targets significantly faster in the onset-related high frequency (10ms) and in the onset-related nonword (13ms) priming conditions as compared to their corresponding unrelated conditions, $F_1(1,$

24)=11.54, *MSE*=119, p<.01; F_2(1, 144)=5.04, *MSE*=1225, p<.05 and F_1(1, 24)=12.16, *MSE*=192, p<.01; F_2(1, 144)=10.74, *MSE*=1124, p<.01, respectively. However, targets were named equally fast when they were preceded by onset-related consonantal strings or by phonologically unrelated consonantal strings (a nonsignificant 2 ms difference; both *Fs*<1).

No significant effects were found in the error rate analyses (all *F*s< 1.1, all *p*s>.2).

Experiment 3 revealed significant MOPEs of comparable magnitude for onset-related high frequency word primes and onset-related nonword primes as compared to their corresponding unrelated controls (i.e., MOPEs of 10 and 13ms, respectively), providing an additional replications of the findings reported in Experiments 1 and 2. However, the effect was absent for the onset-related unpronounceable consonantal primes, as compared to the unrelated unpronounceable consonantal primes (a negligible 2 ms difference). Crucially, the null effect for the unpronounceable primes in the presence of significant MOPEs found for the high frequency word and nonword primes suggests that the MOPE can be obtained only with pronounceable primes and, importantly, irrespectively of the primes' lexical status. These results provide evidence in favor of the SP account which posits that the origins of the MOPE are localized in the speech preparation process (e.g., Kinoshita & Woollams, 2002). At the same time our results are in clear contrast to the predictions of the dual-route theory. If just the initial letter/phoneme of the prime would have been processed by the nonlexical route, as the theory posits, then a significant and highly similar MOPE to those reported with high frequency and nonword primes should have arisen for the onset-related unpronounceable consonantal strings too. However, this was not the case since the 2 ms difference between the onset-related and onset-unrelated unpronounceable priming conditions was unreliable.

Experiments 1-3 have shown that although the frequency and the lexicality of the prime do not modulate the MOPE, the pronounceability of the prime is a key factor that determines the appearance of the effect. Given the relative importance of these findings in validating the SP account of the MOPE and rejecting the interpretation of the effect offered by the dual-route theory we considered it appropriate to perform another experiment, testing again the impact of the prime's pronounceability on the MOPE with another set of materials. In Experiment 4 the same words as in Experiment 2 were used (targets and high frequency primes) along with two new sets of unpronounceable consonantal primes (onset-related and unrelated). The three types of primes of Experiment 3 were now reduced to two (as in Experiment 2), including only high frequency primes and unpronounceable consonantal primes. This was done in order to potentiate the appearance of a MOPE for the unpronounceable consonantal primes (in case it does exist), which could have been masked in Experiment 3 due to the large number of priming conditions (three onset-related and three control conditions) and to the larger number of pronounceable vs. unpronounceable primes. Nonetheless, based on the results of Experiment 3, we predicted the appearance of a significant MOPE for the onset-related high frequency word primes and no effect for the unpronounceable consonantal primes.

Experiment 4: High frequency and unpronounceable consonantal primes

Method

Participants. A different group of 28 native Spanish speakers, all undergraduate students of the University of La Laguna completed this Experiment for course credit.

Materials. The same set of 100 targets and high frequency word primes used in Experiment 2 were also used in this experiment (see Table 4), along with a new set of 200 unpronounceable consonantal strings (100 onset-related and 100 unrelated). The targets (e.g., *NIÑA*, the Spanish for *girl*) could be preceded i) by a high frequency word sharing its initial phoneme with the target (e.g., *noche*, the Spanish for *night*), ii) by a high frequency word phonologically unrelated to the target (e.g., *calor*, the Spanish for *heat*), iii) by an unpronounceable consonantal string sharing its initial phoneme with the target (e.g., *nxwq*), or iv) by an unpronounceable consonantal string phonologically unrelated to the target (e.g., *cxwq;* see Appendix B for a full listing of the materials used). Four lists of materials were created, so that each target word appeared only once in each list. Priming conditions were counterbalanced across lists. Seven different participants were randomly assigned to each of the lists.

Procedure. The procedure followed was exactly the same as in the previous experiments.

Results and Discussion

Incorrect responses (0.25% of the data) and reaction times below or above 2 standard deviations from the mean (less than 2.2% of the data) were excluded from the latency analysis. The mean latencies for correct responses and error rates are presented in Table 7. ANOVAs for the response latencies and percentages of error were conducted based on a 2 (Type of prime: high frequency word, unpronounceable consonantal string) x 2 (Relatedness: related, unrelated) x 4 (List: list 1, list 2, list 3, list 4) design.

(Insert Table 7 around here)

Naming latencies were faster for related prime-target pairs than for unrelated pairs (a 6ms difference), however this effect was only significant in the by participant analysis $F_1(1, 24)=4.32$, *MSE*=221, $p<.05$; $F_2(1, 96)=2.46$, *MSE*=1765, $p>.11$. The effect of Type of prime approached significance, $F_1(1, 24)=3.52$, *MSE*=170, $p=.07$; $F_2(1, 96)=3.96$, *MSE*=704, $p=.05$. Crucially, the interaction between the two main factors was significant, $F_1(1, 24)=8.63$, *MSE*=117, $p<.01$; $F_2(1, 96)=5.83$, *MSE*=502, $p<.05$. The pairwise comparisons performed showed that participants named targets significantly faster when they were preceded by onset-related high frequency word primes as compared to when they were preceded by phonemically unrelated high frequency primes (a 12ms difference), $F_1(1, 24)=12.19$, *MSE*=161, $p<.01$; $F_2(1, 96)=7.16$, *MSE*=1006, $p<.01$. In contrast, participants named the targets equally fast when they were preceded by onset-related unpronounceable consonantal strings and by phonemically unrelated unpronounceable consonantal strings (a -1ms difference; both *F*s<1).

No significant effects were found in the error rate analyses.

The results from Experiment 4 showed a significant 12 ms MOPE for the onset-related high frequency primes, as compared to their controls, and no difference between the onset-related and unrelated conditions for the unpronounceable primes. This pattern of findings is highly similar to the one obtained in Experiment 3 with a different set of materials. However, in the present experiment two out of the six priming conditions of Experiment 3 were removed in an effort to boost a potentially existing MOPE for the unpronounceable consonantal primes. Consequently, the present experiment shows even more firmly that unpronounceable primes do not elicit a MOPE, and further corroborates the validity of the SP account of the MOPE, as opposed to the account of the effect offered by the dual-route theory.

General Discussion

The experiments reported in the present study aimed at exploring which properties of the primes influence the MOPE, in order to identify the origins of the effect. To this end, we performed a series of masked onset priming word naming experiments in which the prime's frequency, lexical status and pronounceability were manipulated. The results of Experiment 1 showed significant MOPEs of similar magnitude for high and low frequency word as well as for nonword primes, suggesting that the MOPE is not affected by the prime's frequency and lexical status. This finding was further corroborated in Experiment 2, in which we exclusively manipulated the prime's lexicality (high frequency words and nonwords). Experiment 3 tested whether the MOPE is sensitive to the pronounceability (pronounceable and unpronounceable) and to the lexicality (words and nonwords) of the primes. Significant MOPEs were only obtained with pronounceable primes, irrespectively of their lexical status, while there was no processing advantage found when the targets were preceded by unpronounceable onset-related consonantal strings. The importance of the pronounceability of the primes for the appearance of the MOPE was further confirmed in Experiment 4. Our results revealed a significant MOPE only when the targets were preceded by onset-related words and not when they were preceded by onset-related unpronounceable consonantal strings.

The first two properties of the masked primes that were manipulated in the present study were the frequency and the lexical status of the primes. To our knowledge, to date there is no published study directly examining the influence of these properties of the primes on the MOPE. In previous studies, significant MOPEs with nonword prime-target pairs have been repeatedly reported (e.g., Forster & Davis, 1991; Kinoshita, 2000; Mousikou, Coltheart, Saunders et al., in press), while significant effects have been also obtained with high and low frequency targets (Malouf & Kinoshita, 2007). In contrast, in the present study manipulations were carried out only on the primes, while keeping target lexicality and frequency constant. Importantly, the lexical status of the primes did not modulate the effects obtained: significant and comparable MOPEs were found for word and nonword primes. The same was true for the prime frequency manipulation, which did not lead to any significant differences in the MOPEs obtained: significant and comparable MOPEs were found for both high and low frequency primes (see Experiment 1). These results challenge the DRC model's account of the MOPE as currently implemented. A recently reported simulation by Mousikou, Coltheart, Sanders (in press) with a set of high frequency primes showed a null effect. The authors noted that "*due to its sensitivity to the frequency of the primes the model could not show an effect with the default parameters*" (p.13). More specifically, words of high frequency would get highly activated in the orthographic lexicon during prime presentation and would then compete very strongly with the targets. Mousikou et al. managed to simulate the MOPE with high frequency word primes and targets by changing the model's parameter settings. Our results using the same targets and manipulating prime frequency and prime lexicality highlight the need for further reconsideration by the DRC model of the way in which the lexical and the nonlexical routes operate when processing briefly presented masked primes [4].

The lack of an influence of the lexicality and the frequency of the primes on the MOPE is clearly predicted by the SP account (e.g., Kinoshita, 2003). Given that the SP account posits that the MOPE arises at the speech preparation process, no modulations of the effect as a consequence of manipulations at the lexical access process (i.e., frequency or lexicality) are expected to emerge. Hence, our findings are in perfect accordance with the SP account of the MOPE.

More critically, Experiments 3 and 4 aimed at testing the different predictions made by the dual-route theory and the SP account regarding the influence of the pronounceability of the prime on the MOPE. Taking into consideration the proposal of the dual-route theory, according to which the MOPE depends on the processing of the primes, pronounceability was exclusively manipulated on the primes. From the dual-route perspective, in the cases in which the initial letter/phoneme of the prime matches that of the target, the rest of the letters/phonemes of the prime would not affect the expected MOPE. Hence, this theory would predict comparable MOPEs for targets preceded by onset-related primes, irrespectively of whether these are pronounceable or unpronounceable. Our results did not support the predictions of the dual-route account of the effect, since we did not obtain significant MOPEs with unpronounceable primes (nonsignificant 2 and -1ms differences in Experiments 3 and 4, respectively). This finding suggests that masked primes are indeed processed beyond their initial letter/phoneme in a way critical for the appearance of the MOPE, contrarily to what the dual-route theory posits (e.g., Coltheart et al., 2001; Mousikou, Coltheart, Saunders et al., in press). This is in line with previous evidence showing that not only the initial letter/phoneme of masked primes is processed (e.g., Horemans & Schiller, 2004; Masson & Isaak, 1999).

The findings reported by Carreiras et al. (2005) are of special relevance to the present study. The authors conducted a word naming experiment and found a significant masked priming effect with French target words preceded by nonwords sharing their initial phonological syllable (e.g., *fomie*-*FAUCON*), which was significantly larger than the mere MOPE (e.g., *fémie*-*FAUCON*). Similarly, Schiller (1998, Experiment 5) found a monotonic increase of masked form priming effects in Dutch: the effects increased as a function of segmental overlap between primes and targets, from just an onset overlap (e.g., *h%%%%%%*-*HUILEN*) to complete overlap (e.g., *huilen*-*HUILEN*). The author proposed that this pattern of effects was the result of the facilitation in the production of the phonological segments of the target due to their pre-activation by the previously presented prime (see also Schiller 2000; 2004, for further evidence). Mousikou and colleagues (Mousikou et al., 2009) have recently tested whether the masked orthographic/phonological priming effects extended beyond the initial letter/phoneme by replicating an experiment initially reported by Kinoshita (2000, Experiment 1). Kinoshita found that targets preceded by primes starting by the same two letters/phonemes (e.g., *sif*-*SIB*) were named equally fast as those preceded by primes sharing only their initial letter/phoneme (e.g., *suf*-*SIB;* a non-significant 3 ms difference). However, Mousikou and colleagues used a much larger set of experimental items and obtained a different pattern of effects. They found that when the overlap between primes and targets was extended to the first two letters/phonemes the participants named the targets faster as compared to when the overlap was restricted to the initial letter/phoneme. Finally, the results of the pronounceability manipulation bring to light another limitation of the DRC model. The model lacks of any knowledge of graphotactics and hence it cannot identify whether a given letter-string is composed of graphotactically legal or illegal sequences of letters/phonemes, like the unpronounceable consonantal primes used in Experiments 3 and 4 (see also Seidenberg et al., 2009, for further evidence). Hence, our results highlight the necessity of inclusion within the DRC model's architecture of such a mechanism.

The finding that the MOPE depends on the pronounceability of the primes shows that masked primes are effectively processed beyond their initial letter/phoneme and that the relative difficulty in pronouncing the string of letters that follows the initial one is critical for the appearance of the MOPE. These results can be perfectly accounted for by the SP account (e.g., Kinoshita, 2000). The absence of any MOPE for the unpronounceable consonantal primes together with the presence of significant MOPEs for pronounceable words (Experiments 3 and 4) and nonwords (Experiment 3) indicates that the origins of the effect could be indeed located in the speech preparation process (e.g., Malouf & Kinoshita, 2007). The SP account of the MOPE proposes that the preparation of the utterance of a word can proceed only after the preparation of its initial phonemic segment. Furthermore, based on evidence from language production studies (e.g., Dell, Juliano, & Govindjee, 1993), the SP account posits that this critical phonemic segment is the initial syllabic onset. The syllabic onset of a given word is defined as the consonantal cluster preceding its first vowel. For words starting with a CV syllable the syllabic onset coincides with the words initial letter/phoneme (e.g., *bingo*). For words starting with a CCV syllable the syllabic onset extends to the two first consonants (e.g., *bliss*), and it is otherwise identified as a complex onset. Kinoshita (2000, Experiment 2) found that the MOPE is absent for targets with complex onsets sharing their initial letter with single onset primes (e.g., *bingo*-*BLISS*) and argued that the appearance of the MOPE depends on the overlap of the syllabic onset between prime and target (but see Mousikou, Coltheart, Saunders et al., in press; Schiller, 2004 for evidence in the opposite direction) [5]. Accordingly, it is feasible to assume that the participants of the present study could not prepare the utterance of the syllabic onset of the unpronounceable consonantal strings used as primes in Experiments 3 and 4 since there was not a vowel to guide the segmentation of the syllabic onset of the prime (e.g., *nbljm*). Consequently, we interpret the lack of a MOPE for targets preceded by unpronounceable onset-related primes as reflecting a failure of the planning of the utterance of the prime. This approach could also account for the significant MOPEs obtained by Schiller (2004, 2008) for onset-related primes containing just a single letter (e.g., *b%%%%%-BALLET*). Even though this type of primes could initially be taken as unpronounceable, their syllabic onset can be easily isolated from the rest of the non-letter string, contrary to the syllabic onset of the unpronounceable consonantal primes used in Experiments 3 and 4 of the present study. Consequently, the match between the syllabic onset of the single-letter primes and their corresponding targets would give rise to the MOPE.

As a final remark regarding the SP account, it should be mentioned that given that this account considers that the sequential nature of the MOPE arises outside the lexical access process (e.g., Kinoshita, 2000; Malouf & Kinoshita, 2007), it is in principle compatible with models assuming a parallel computation of phonology from orthography across the letter string, like for example the *Parallel Distributed Processing* model (PDP; Plaut, McClelland, Seidenberg, & Patterson, 1996) or the *Connectionist Dual Process* model of reading aloud (CDP; Zorzi, Houghton, & Butterworth, 1998). Following this line of reasoning, the print-to-sound mapping could take place in parallel and then, in a subsequent processing stage, the selected phonetic segments to be produced would be serially associated to the corresponding metrical frames (e.g., Roelofs, 2004).

Despite the fact that the DRC model cannot account for the absence of a MOPE for unpronounceable consonantal primes, there is still a model assuming the existence of two routes and ascribing the MOPE to the serial operation of the nonlexical route, which could potentially accommodate this finding: the CDP+ model of reading aloud

(Perry, Ziegler, & Zorzi, 2007). In fact, the CDP+ model has successfully simulated the MOPE. Similar to what the SP account and the results from our Experiments 3 and 4 suggest, the CDP+ model assumes that the relevant processing unit for the MOPE is the first available syllabic onset, and not the initial letter/phoneme of the prime. The syllabic onset of a given word is identified within the CDP+ through the operation of a *graphemic buffer* which parses the word into syllabically structured graphemes (i.e., onset, vowel and coda). Accordingly, the CDP+ would propose that the processing of the unpronounceable consonantal primes would have been hampered since their parsing into graphemes would have not been possible (J. Ziegler and C. Perry, personal communication, November 2009). This would consequently lead to the absence of a MOPE for these primes. In line with this interpretation of our findings, in the study by Seidenberg et al. (2009) showing that nonwords containing graphotactically illegal sequences of letters are harder to read aloud than nonwords containing legal multiletter graphemes, the authors showed that the CDP+ model could successfully simulate these data (while the DRC did not). Still, before accepting the account of the MOPE offered by the CDP+ as a valid one, it remains to be seen whether the model could successfully simulate not only the present data but also the data reported throughout the existing MOPE literature.

In summary, our results showed that the MOPE is not affected by the speed with which the masked primes activate their lexical representations. Crucially, the MOPE has been probed to depend on the pronounceability of the primes, thus providing further support to the Speech Planning account, which proposes that the effect originates at the speech preparation process.

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Appendix A

Stimuli used in Experiments 1 and 3

Primes								
Exp. 1 & 3 High Frequency		Exp. 1 Low Frequency		Exp. 1 & 3 Nonwords		Exp. 3 Consonantal strings		
Rel.	Unrel.	Rel.	Unrel.	Rel.	Unrel.	Rel.	Unrel.	Targets
leer	cosa	lata	raya	lefu	cusi	lpgz	mxbf	LOBO
puerto	vuelta	partir	gozosa	pusriu	vucimu	pwqgxb	twgzrx	PEGADO
campo	fondo	cañón	belén	coslo	foszi	cwgqn	nwgzb	CURVA
marcha	salido	melena	rabino	macrua	zilfes	mxbkzg	pzfbjs	MONTAR
tomar	balón	tecla	fonda	tejis	begla	tflcb	mxtfj	TURNO
cuento	dinero	cometa	gentío	curefo	resgro	cjmwxr	ltpnwm	CAMBIA
toda	falta	tierna	fingir	tavu	piñu	tflbcx	cvñpkb	TESORO
tanta	bolsa	tarta	danza	tasfi	binza	tfbkñ	lxptn	TUMOR
camino	fuente	cadera	ganada	culifu	tulmis	cjñbbr	nfqgpb	COBRAR
pagar	vieja	panda	fiera	pafer	veñas	pfrxm	mzxpñ	PULSO
tomado	vivido	toalla	firmar	tapufo	cusplo	tfñgmj	cvpbñk	TIMBRE
poesía	sexual	pincel	jovial	porisu	rimezi	pfjbñk	txlnñb	PAGADO
muerte	normal	molino	joyero	muifle	disple	mwgzrt	pxsjwñ	MANCHA
malo	debe	moto	jefa	mufe	dexo	mwxz	lpñf	MINA
punto	ruido	pajar	filón	pugro	ruomo	pfñbt	cxgñw	PESCA
copa	diez	cuna	feto	cufa	diñu	cdkm	lpkb	CARO
lejos	dejado	lujoso	jazmín	lepus	zorcle	lprgtz	mzqnpb	LIMPIA
pueblo	vuelto	parche	radial	puoflo	fimilo	pwjxlm	cwkrlm	PESADA
papel	salvo	pasivo	recato	paful	nifail	pfzwxl	cvmñxt	POSEER
leche	vuelo	lesión	guante	lesle	mescol	lpfñsw	nwñtmf	LANZAR
piel	cama	piña	remo	puji	cili	pfjm	cjñp	POZO
techo	suelo	tapón	fobia	teslu	soego	tfñkj	lwnqt	TIRAR
lugar	julio	litro	burro	lufin	jusco	lpbzk	nwmfñ	LANZA
niño	bajo	nata	rota	nifo	biña	nfgñ	mxbk	NUBE
tipo	pelo	toro	buey	tibu	pehu	tfbl	cvsn	TAZA
local	gesto	licor	burra	lojus	gepco	lpgñw	nwmpv	LATÍN
medio	salón	muslo	burda	milai	sapil	mwñfz	txnbñ	MOVER
ningún	seguir	neutro	rebaja	nirtul	pasfle	nfpqbg	txmjnr	NOCIÓN
perro	ritmo	pollo	boxeo	piplo	ruzco	pfmxj	txrnm	PASTA
modelo	nación	maldad	gustar	mufuji	dizuni	mwñxvp	nxpzfw	MEJORA
teatro	señora	templo	feudal	tinofo	pusnin	tfbsxj	mzxñpr	TALLER
cuadro	figura	coleta	gentil	culefo	bespil	cjlñtm	ltmrxp	CARBÓN
costa	feliz	culta	debut	cufri	femul	cjñmt	mxgzb	CASCO
contra	jardín	calmar	gitano	cosdis	rilflo	cjrnxp	nwñmvp	CUMBRE
misión	diario	mimbre	jersey	mizuor	pifuzo	mwfñsj	nxpbqj	MALETA
lograr	busca	latido	gozoso	lochur	piñufo	lpgzrt	nwvñpm	LEJANA
larga	morir	lunar	boina	larnu	muñer	lprtg	pwmlj	LISTO

coche	demás	cueva	bolso	cospe	defís	cdlsn	lpzfx	CAJÓN
carta	decir	casta	banal	caplu	dulus	cjpbñ	mxjfñ	COGER
pasa	deseo	pera	ruin	pefa	demta	pfbk	cjñm	PICO
tarde	viaje	tapar	farol	tascu	vugre	tfxcl	lxbjq	TONTO
cadena	juicio	caseta	jabalí	cuñefe	gusmil	cvbpnt	nfxmpw	CORTAR
comer	buen	cupo	bote	cefur	buil	cdgn	lpgr	CAOS
contar	doctor	conejo	gancho	cospun	jiospo	cdxmñl	nwmñft	CUERDA
mala	cara	maíz	bala	mavu	cavi	mwzt	nfgr	MONO
correr	sabido	casino	gemido	coblel	piesgo	cvbsln	nwbkzg	CUARTA
comida	verano	canoso	garaje	cogalo	fatlol	cdngsl	nwkgbz	CUBRIR
marco	vamos	mafia	ducha	mistu	vizos	mwxpv	lwgqn	METAL
mano	nada	moco	sana	mabo	nago	mwgr	lpnw	MIEL
peor	jefe	peón	fiar	pedu	jelu	pfbj	mxbn	PAGO
pasado	social	postre	ración	pijimu	fiñuci	pfqñjb	txfgnq	PELOTA
tesis	silla	tigre	fijar	tepen	surru	tfmjñ	nfztr	TACTO
poder	según	pasaje	refrán	pumun	vemaza	pwxqbg	twkrjx	PILOTO
teoría	veinte	tambor	receta	tiufua	puscal	tfxbjs	cvpznw	TORNEO
carga	dejar	capo	vago	cuspi	deñis	cdls	ltmj	COLA
menos	joven	melón	duque	mecon	jonel	mwjñn	pwxbq	MAGIA
tabaco	visita	tomate	filial	tamaru	fazuna	tfbxlc	nfgzrt	TEJIDO
cabeza	fiscal	canela	fulgor	cajifa	ruzasa	cjpñbq	nfsjwñ	COMITÉ
lector	doble	lavado	jarrón	lefcon	duñozo	lpngwñ	mzpqbn	LIGERA
moral	justo	morbo	batir	mucil	juspo	mwrtg	ltpwn	MANDA
marido	sector	mueble	juzgar	mubizu	sujipi	mwzxfñ	pzbxlt	MONEDA
pensar	sentir	pulmón	recibo	puftus	fouñes	pwrgtz	twñrxp	PIEDAD
tarea	venir	tejer	finca	tafia	vafis	tfxjb	cxrpg	TOQUE
común	golpe	cutis	dogma	cuson	guspi	cjmxw	mxfnb	CARRO
libro	juego	labio	dardo	lisco	juafo	lpmpv	pfxlz	LENTA
pecho	seria	pactar	rojiza	pasle	risful	pxjgwñ	mztgnq	PINTOR
caída	fuego	cazar	barón	canua	fiagi	cjrxm	mxpnz	COSTE
lengua	radio	laurel	racial	luntau	sufuna	lpñmvp	mzpnwj	LIGERO
mando	jamás	manta	facha	manfo	jagós	mwvpñ	ltxpm	MEDIR
nacido	seres	navaja	jornal	nofugo	pougro	nfjñsw	txñbqj	NIEBLA
manera	sangre	masivo	ranura	mufeci	senfis	mxbsfn	txfzlw	MORTAL
libre	firme	latir	burla	lipsu	firzu	lpgzb	nwñfz	LECHO
lengua	dentro	latina	jauría	lemfoe	viglos	lpbkzg	pxmñzf	LUCHAR
matar	salir	momia	delta	mafur	sagia	mwñjs	txnqf	MUSEO
cambio	famoso	calcio	furgón	custur	muñiti	cjñqpb	nfrgtz	COLEGA
lunes	buscar	ladrar	jinete	lufas	zugle	lpsfwñ	mzrxkj	LIMPIO
poner	resto	pezón	fiero	poful	rinfo	pfnbñ	cwtbq	PAUSA
piedra	segura	postal	retina	pilefe	ciñele	pfjrmx	txnfqg	PARADO
culpa	dicha	cursi	belga	curma	dilge	cdxñm	ltkjr	CANTO
cuello	bosque	cuervo	fundar	custue	futeje	cdglns	lpwnñg	CAMIÓN
casa	dolor	calva	balsa	cafi	doñis	cdkmñ	mxptn	CUERO

media	fuera	molde	dudar	meltu	fuzin	mwgñj	pwrtg	MACHO
pienso	señor	papada	regazo	pisfue	benzon	pftnñb	nfpxwm	PORTAL
nunca	señal	nieto	diosa	nusto	soñus	nfgbp	txqjñ	NACER
lucha	forma	lucir	diván	lusja	firza	lpñws	pwgbx	LEÍDO
puerta	semana	peluca	rizado	puslie	fispil	pfñbqj	txqñjb	PATRÓN
negra	razón	nadar	danés	nufta	ragru	nfñws	cxzpr	NOBLE
mito	dios	moño	velo	munu	dizo	mwfs	cjnr	MAPA
temor	viejo	tutor	fisco	tuzun	vapla	tñgsw	cxspf	TORRE
carne	ganas	cable	bedel	cesve	gabre	cjbrb	nwbzk	CULTO
tono	duro	tubo	buzo	toju	duju	tfbk	lpxz	TAXI
cuesta	fuerte	collar	guinda	cupru	pefuñi	cjnprx	ltpqbn	CASADO
mucha	reina	monje	duela	munfe	rejus	mwsjf	ltrpx	MARZO
tanto	virus	tenor	dorso	tarlo	vorfo	tñpws	lxpnz	TUMBA
nadie	vivir	nasal	bulto	nipiu	vigus	nfpbq	txñbl	NORMA
marca	salud	misil	faena	majri	sañiz	mwzfx	lwmxf	METER
puesta	sombra	pijama	rareza	puarja	cumala	pfñtbn	twpnwj	PEDIDO
nueva	sacar	nuera	densa	nuafe	sapue	nfgñw	cxbzk	NOVIO
tierra	verdad	tarifa	rebote	timeja	ruñife	tfñjkb	cvñtmx	TOCADO
cuerpo	fiesta	cogote	gemelo	cuislo	despol	cdmlxñ	lpzxfñ	CANTAR
perder	volver	payaso	recodo	poflos	bouclu	pwxmjl	twnjpw	PIERNA
causa	boca	cava	gira	catia	bofa	cdmx	ltmw	CULO
lado	buena	lana	raíz	laku	buzis	lpgñ	cjlt	LEVE
motivo	rostro	muñeco	juntar	monifo	bouspu	mwvñpx	nxpbñk	MIERDA
cuenta	guerra	compás	gitana	culiji	vejupe	cjbñrb	ltnmpw	CARIÑO
luego	visto	latino	gusano	lusus	pisfe	lpvñpm	pxjñsw	LOCURA
modo	caso	mago	bobo	mogo	cudu	mwñf	nfgb	MISA
cuarto	futuro	cartel	gastar	cusjie	fizise	cjwrmx	nfxgwñ	CORONA
pasión	sujeto	paloma	rienda	panuon	cungas	pwgzrt	cvzwpn	PERFIL
punta	jugar	peine	botón	purji	jilmi	pfbkñ	lxsnf	PASEO
pasada	suerte	paliza	rancio	pamaju	gislis	pfxzlw	cvqplb	PERDÓN
padre	sitio	pudor	busto	pigli	sutiu	pfqjñ	nfswj	POEMA
pieza	serie	peste	farsa	pilme	sengi	pfbjq	lxtfm	PACTO
mejor	duda	mazo	faja	mezil	diña	mwxp	pfrx	MURO
mirada	visión	marrón	rayado	milici	loinfi	mxfbns	txjrmn	MUERTA
medida	salida	masaje	juerga	melala	risgul	mxbpnt	pzkgbw	MONTÓN
tema	juez	tapa	beca	tuge	juba	tfbx	cvtx	TIRO
madera	rincón	mantel	rancho	mufuje	vafuñu	mwsfjñ	nxñpkb	METIDO
mayor	siglo	mudar	durar	mujis	siñis	mxbkñ	cxvpñ	MONTE
mezcla	región	minero	jugosa	muftio	pilfol	mwngjñ	pxwjñg	MARTES
pareja	simple	paella	ribera	pifuni	lumisi	pfñjkb	txzwfl	PECADO
tercer	calor	torero	filtro	toplun	lospo	tfmñjg	cvpbql	TIENDA
luna	casi	laca	goma	lafa	caji	lpfs	cjbr	LEÓN
cuatro	buenos	cohete	fulano	cufrue	refuzo	cdlkñm	lpxñzf	CAMISA
color	dicho	coser	bicho	cufir	dinso	cdnsg	lpwñn	CALMA

mujer	ganar	monja	falla	mufas	gafla	mwztr	lwnbñ	METRO
curso	fecha	cojín	botín	cuplo	fefor	cdñml	lpztr	CANAL
largo	gente	logro	buzón	lusjo	gosco	lpswf	pwjlx	LETRA
negro	siete	natal	denso	nelpu	sueje	nfrtg	txwlf	NOVIA
labor	dueño	limón	bingo	lifon	duiñu	lpñfz	pfwlx	LEGAL
puesto	seguro	pelvis	rictus	puncuo	meglos	pfmjxr	txñlbn	PATRIA
lista	fuerza	librar	gorila	lipla	zusipi	lpkgbz	mzntqg	LEJANO
mesa	bien	menú	gata	mepu	buje	mwgñ	cjñb	MAYO
madre	reloj	mango	dueña	mispe	rebin	mxbzk	cxwñn	MOTOR
loco	barrio	lino	reto	lopu	bufneo	lpmp	mwñj	LIGA
poeta	saber	pelar	fogón	pusli	selfu	pfñkj	cxlpv	PIANO
texto	vacío	telón	fuero	tefli	vilui	tfsjx	lwrxm	TOCAR
capaz	gusto	casar	bambú	carul	gurfa	cjpxr	mxñkp	CONDE
calle	final	cauce	bahía	casfe	fijus	cjqbp	mxntb	CORTO
mañana	recién	marcar	jungla	malaja	feleja	mwxñzf	pzbsfj	MINUTO
muerto	riesgo	mojado	gomina	musolu	garbis	mwrgtz	pzbkwg	MENTAL
corte	bueno	cobre	betún	colje	beule	cdlñx	lpvpñ	CAÍDO
cuanto	ganado	calzón	gestor	cuftia	bosgle	cjtlmñ	nfwxñg	COMPRA
tamaño	viento	tanque	fianza	tufuvi	sallis	tfjbñk	cvnbtp	TERROR
cocina	dormir	cordón	genial	corenu	megifi	cdñlmk	ltkrjm	CANUTO
millón	novela	mechón	jugada	mespel	cusefe	mwjnñg	pzlbtx	MARINO
masa	cabe	miga	sano	muña	cazu	mwñv	nfjs	MOZO
nombre	vista	niñez	dobla	noflis	vilju	nfmwp	cxzfp	NEGAR
nariz	verde	ninfa	fango	nifuz	vusfe	nfpwx	lxwnp	NOTAR
total	sueño	tenis	folio	topur	supro	tfgjm	nfwñx	TABLA

Appendix B
Stimuli used in Experiments 2 and 4

Primes						
Exp. 2 & 4		Exp. 2		Exp. 4		
High Frequency		Nonwords		Consonantal strings		
Rel.	Unrel.	Rel.	Unrel.	Rel.	Unrel.	Targets
doña	pues	doja	puej	dfpm	pksj	DEDO
bolsa	regla	bonda	refta	bpmrf	rxtf	BAJO
cual	peso	cuar	pefo	cplw	pqnx	CABO
dejar	punto	deñal	pusco	dzñlf	pqnzk	DUDA
lento	tiro	lesdo	tijo	lxpft	tfkd	LUGAR
mala	barco	mafa	barpo	mvpl	bvryr	MOÑO
fijar	salto	fidas	sarjo	fñtws	sxvnr	FUGA
leer	roto	leel	rogo	lñpr	rxng	LADO
busca	reojo	burga	reoco	bxlfg	rzjwd	BAÑO
fuera	rodaje	fueja	roñame	fjmnz	rwktsp	FÁCIL
gusto	papel	guzpo	paker	gftmp	pcflx	GIRO
feliz	pierna	fejin	piesca	fdpzc	zmntrd	FALLO
suave	gorda	suage	golga	sxbvm	gtqpf	SEÑA
sede	leña	sefe	leja	sñmd	lxjdr	SUSTO
paro	campo	pafo	casro	pmdb	czqlr	PENA
rubio	dentro	rulio	desglo	rxqsl	dfrwnc	REMATE
suya	bala	suta	baxa	sxwj	bjmt	SINO
suerte	ladrón	suepte	laftón	sxmrql	lxtrgm	SOLA
pelea	casa	peñea	caha	pkqyt	cflq	PAÍS
belén	rato	bejés	rago	bkwps	rxnk	BOLA
pecho	césped	perpo	célmel	pmclb	cbvlsw	PASAR
salir	cien	sapin	cier	sñrnw	cmrb	SITIO
malo	barra	maho	banga	mfls	bmwgx	MUJER
basa	toalla	bafa	toarra	bxlp	tdqyxz	BIEN
faltar	tajo	fascan	tamo	fzpñgx	tksx	FIEL
tanta	guión	tasla	guiól	txnqd	gflrw	TIEMPO
tarde	cifra	tanve	cilna	tzjwl	cfmwl	TORO
pesca	cosa	pelfa	coya	pknbm	cqzn	PADRE
noche	calor	nople	cazol	nbljm	cqrtk	NIÑA
bello	pagar	berdo	pañas	bñrpl	pwtmd	BOCA
lunes	nena	luril	neña	lxcpñ	nqfd	LUEGO
seis	goma	seir	goña	sñnm	gdmq	SALA
como	niñez	covo	niges	cvpñ	nprs	CAJA
doce	fugaz	doke	fuñar	dqlg	fkwqm	DIOS
fondo	pueblo	foslo	puegro	fxplw	pgntlj	FECHA
muerte	caído	muelpe	caílo	mgldjp	cgrfl	MISMO
gente	tela	gerpe	teña	gjptd	tkrf	GANA
buscar	morado	buljas	mopaño	bjrmsp	mrfvsr	BASADA
cabe	mira	cahe	mipa	cwrt	mtfv	CODO

finca	techo	fimpa	tembo	fdzvp	tqlgp	FUERTE
misma	barro	milpa	baplo	mgpjk	bxglq	MUNDO
rota	delito	rona	defizo	rwmz	dqstgn	RELOJ
mucho	bonita	muflo	bojiza	mwplt	bwqltn	MARCO
bondad	sudor	bolfan	suños	bwkljg	szywd	BASURA
caer	toda	cael	tofa	cpñr	txjf	COLA
buena	pito	buepa	pifo	bwpzj	pdcm	BALÓN
daño	peor	daco	peol	dkpt	pjxn	DIEZ
receta	lata	refeza	lafa	rkqnbv	lñmt	RISA
sombra	diente	sorpta	dierge	sñtvbx	dxrwpz	SUELO
mina	dócil	mifa	dóñis	mkgt	dkntl	MORO
feroz	pintor	fetor	pisfol	fdrcv	pmrntv	FUEGO
socio	guerra	sojio	guenja	sxjrt	gjrlnm	SEDA
falda	nuevo	fasma	nueño	fzplñ	nkxbn	FERVOR
furia	diosa	fumia	dioca	fpqms	dxmqk	FALTA
butaca	nula	bumafa	nupa	bfzplm	nprf	BIGOTE
baja	pero	baga	pejo	bjrn	pxtg	BESO
recién	desdén	reliés	delfél	rxnklm	djxzng	ROSTRO
pozo	cuerpo	poxo	cuembo	pjrm	cxtrgz	PIEL
nieto	calvo	niezo	casmo	nwplt	cfgrt	NUCA
barrio	débil	ballio	déjis	bqjgmr	dzmkg	BUENO
lejos	pase	lefot	pade	lwrpj	pgrn	LUTO
bata	tapia	bama	tagia	bfzp	tprfs	BUEN
saca	gordo	safa	gompo	sxmz	gqmrl	SEGÚN
lejano	rubor	lepazo	rudol	lñvbps	rzfts	LENGUA
nido	camino	nigo	cavizo	nbñs	cxrgmz	NUNCA
loco	nada	lojo	naza	lñfd	nkgj	LUNA
feria	paseo	femia	pañeo	fsptw	pgtrp	FILO
dura	rojo	duga	roho	dzlw	rjvn	DADO
dicho	nueva	dispo	nuega	dfbnm	nkptf	DOLOR
saldo	gozar	sasjo	goñal	sñtkt	gzydf	SANGRE
salud	lana	sazul	laña	sxmlq	lxwg	SUEÑO
rana	lino	raga	lixo	rwnm	lxgm	REÍR
siglo	funda	simpo	fulma	sxztq	fjmtn	SABER
beber	silla	bedes	sirra	bzlñm	sxdfn	BOSQUE
decir	muñeco	defin	mulejo	dwplg	mctfkw	DORADA
fijado	raso	filaño	rado	fqbvzd	rzwq	FUENTE
pese	cuatro	pede	cuaplo	pjrn	cfxwzl	PAGO
farol	nube	famot	nuse	fjtdg	nxrk	FILA
loca	nave	lofa	naje	lñsp	nqdm	LIBRE
fumar	nieve	fujal	nieñe	fklpw	nxrtc	FOCO
pista	cuesta	pinfa	cuerja	pfkrn	cjgqrt	PELO
ganar	polvo	gagas	posjo	gñrts	pxwjs	GOLPE
mesa	bolso	mefa	bofpo	mxzp	bfdcs	MUERTO
nadar	calle	nagas	capre	npljs	cvxrm	NINGÚN
muro	cabeza	mujo	careña	mvpf	cqtglw	MAÍZ

debido	mañana	dejiño	mafaca	dfzmbñ	mtwqfl	DINERO
contra	suegra	colfla	suelpa	cflpzx	sjfrwq	CADENA
leve	sida	lehe	sifa	lxfd	sxnt	LIBRO
niño	cambio	nijo	carlio	nwjf	cjrtgk	NADIE
bonito	tierra	bojico	tiefla	bfjkñl	tqdmzf	BASTÓN
miel	cada	miez	cafa	mwsl	cdlb	MANO
lanza	pavo	laspa	pafo	lxpñt	pdfr	LUCHA
puesto	culpa	puempo	custa	pfmntsw	cxmtd	POBRE
leche	meta	legle	mefa	lwbxz	mtrn	LOCURA
siete	dulce	siere	dumpe	sxjlg	dzglq	SUBIR
sostén	gota	solpés	gofa	sñnwkl	gqrj	SUFRIR
selva	duro	senta	dupo	sñqkl	dxbr	SUYO
tanto	boina	talfo	boifa	tñgfl	bgnmd	TOQUE
bella	mitad	berpa	mifan	bzmtp	mtdfr	BODA
razón	desde	rañós	delge	rwjnb	dznmf	RUEDA

Footnotes

1. In a recent experiment, Mousikou et al. (2009) tested once more the dual-route's proposal that only the first letter/phoneme of masked primes is effectively processed in a masked onset priming experiment with nonword prime-target pairs. In contrast to what the theory predicted, the authors found shorter naming latencies when the primes shared the first two letters/phonemes with the targets as compared to when they shared only the first letter/phoneme. However, the larger benefit (4 and 5ms in the subject and the item analysis, respectively) for the two letter/phoneme overlap, appeared only for two third of the participants. The authors concluded that the reason for this unexpected difference was the sometimes faster operation of the nonlexical route of this subgroup of participants (see also Thompson, Connelly, Fletcher-Flinn, & Hodson, 2009, for evidence in the same line).

2. The DRC model has successfully simulated MOPEs with word primes of varying frequencies with different sets of materials (see Mousikou, Coltheart, Saunders et al., in press; Mousikou, Coltheart, & Saunders, in press). However, further information regarding the frequency of the specific primes that gave rise to the effects reported in these simulations has not been provided. The only simulation in which a sub-analysis of the primes as a function of the MOPEs observed was the one carried out with the materials used by Forster and Davis (1991, Experiment 1). As mentioned, in this simulation the DRC did not produce a significant MOPE due to the inclusion of some very high frequency primes (Mousikou, Coltheart, & Saunders, in press).

3. Despite the fact that the MOPE for nonword primes was only significant in the analysis by participants, it should be clearly noted that the critical interaction between Type of prime and Relatedness was not significant in either the participant or the item analysis (both *F*s<1.9, both *p*s>.28), and therefore there was no statistical need for the pairwise comparisons (i.e., these tests are only reported in order to show the consistency of the data).

4. Acknowledging the fact that the lexical activation of masked primes is problematic for the DRC model, Mousikou, Coltheart and Saunders (in press) have recently stated they are currently trying to minimize it. By reducing the lexical activation of masked primes, the DRC model could potentially simulate the significant MOPE with high frequency prime words. Nevertheless, if such a modification were to be implemented, it would be unclear how the model could simulate existing evidence from other masked priming effects, reported in the reading aloud and the lexical decision literature, which have been shown to be modulated by the prime's frequency or lexical status (e.g., Andrews, 1996; Duñabeitia, Molinaro et al., 2009; Duñabeitia, Perea et al., 2009).

5. The possible reasons for the discrepancy across the results obtained in the MOPE studies reported by Kinoshita (2000), Mousikou, Coltheart, Saunders et al. (in press) and Schiller (2004) have not been clearly identified. Mousikou and colleagues proposed as a potential reason the different methods used to measure the responses to the targets. Kinoshita and Schiller used voice keys, while Mousikou and colleagues used the CheckVocal software to hand-mark the responses of their participants. It should be also mentioned that Schiller's onset-related primes consisted of one or two letters followed by a string of percent signs (e.g., *b%%%%%-BROEDER*, *br%%%%- BROEDER*), while both Kinoshita and Mousikou et al. used full letter primes. This difference could have affected the obtained pattern of effects in various ways, since the processing of symbols is fundamentally different to the processing of letters (for further discussion of this point see the Results and Discussion section of Experiment 2 and the General Discussion).

Table 1

Overview of the manipulations included in the four experiments with examples of the items presented in each experimental condition.

		Priming Condition							
		High Frequency		Low Frequency		Nonwords		Cons. Strings	
Exp.	Target	Rel.	Unrel.	Rel.	Unrel.	Rel	Unrel	Rel	Unrel
1	*CURVA*	*campo*	*fondo*	*cañón*	*belén*	*coslo*	*foszi*	-	-
	(curve)	(country)	(bottom)	(canon)	(crib)				
2	*NIÑA*	*noche*	*calor*	-	-	*nople*	*cazol*	-	-
	(girl)	(night)	(heat)						
3	CURVA	*campo*	*fondo*	-	-	*coslo*	*foszi*	*cwqgn*	*nwqgs*
	(curve)	(country)	(bottom)						
4	*NIÑA*	*noche*	*calor*	-	-	-	-	*nbljm*	*cqrtk*
	(girl)	(night)	(heat)						

Note: Exp., Experiment; Rel., Related; Unrel., Unrelated; Cons. Strings, Consonantal Strings.

Table 2

Characteristics of the materials used in Experiments 1 and 3. English translations of the examples used are presented within parentheses. Overlap is given as the number of common letters between primes and targets.

		Priming Condition							
	Exp. 1&3	Exp. 1&3		Exp. 1		Exp. 1&3		Exp. 3	
		High Frequency		Low Frequency		Nonwords		Cons. Strings	
	Target	Rel.	Unrel.	Rel.	Unrel.	Rel.	Unrel.	Rel.	Unrel.
	CURVA	*campo*	*fondo*	*cañón*	*belén*	*coslo*	*foszi*	*cwqgn*	*nwqgs*
	(curve)	(country)	(bottom)	(canon)	(crib)				
Freq,	22	148	132	7	6	-	-	-	-
Let.	5	5	5	5	5	5	5	5	5
Phon.	5	5	5	5	5	5	5	5	5
Syl.	2	2	2	2	2	2	2	-	-
N	5	5	3	5	3	1	1	-	-
Over.		1	0	1	0	1	0	1	0

Note: Exp., Experiment; Cons. Strings, Consonantal Strings; Rel., Related; Unrel., Unrelated; Freq., Frequency; Let., Number of letters; Phon., Number of phonemes; Syl., Number of syllables; *N*., Number of orthographic neighbours; Over., Letter overlap with the target. The different measures were taken from B-Pal (Davis & Perea, 2005).

Table 3

Mean naming latencies (in ms) and percentages of errors (within parentheses) associated with each experimental condition of Experiment 1.

	Priming Condition		
Type of Primes	Onset-related	Unrelated	MOPE
High Frequency	585 (1.2)	594 (1.1)	9* (-0.1)
Low Frequency	586 (1.4)	599 (0.9)	13* (-0.5)
Nonwords	588 (1.2)	595 (0.9)	7* (-0.3)

Note: Statistical significance is indicated with an asterisk (*)

Table 4

Characteristics of the materials used in Experiments 2 and 4. English translations of the examples used as well as standard deviations are presented within parentheses. Overlap is given as the number of common letters between primes and targets.

		Priming Condition					
	Exp. 2&4	Exp. 2&4		Exp. 2		Exp. 4	
		High Frequency		Nonwords		Cons. Strings	
	Targets	Rel.	Unrel.	Rel.	Unrel.	Rel.	Unrel.
	NIÑA	*noche*	*calor*	*nople*	*cazol*	*nbljm*	*cqrtk*
	(girl)	(night)	(heat)				
Freq.	139	136	137	-	-	-	-
Let.	5	5	5	5	5	5	5
Phon.	5	5	5	5	5	5	5
Syl.	2	2	2	2	2	-	-
N	6	6	6	4	4	-	-
Overl.	-	1	0	1	0	1	0

Note: Exp., Experiment; Cons. Strings, Consonantal Strings; Rel., Related; Unrel., Unrelated; Freq., Frequency; Let., Number of letters; Phon., Number of phonemes; Syl., Number of syllables; *N*., Number of orthographic neighbours; Overl., Letter overlap with the target.

Table 5

Mean naming latencies (in ms) and percentages of errors (within parentheses) associated with each experimental condition of Experiment 2.

	Priming Condition		
Type of Primes	Onset-related	Unrelated	MOPE
High Frequency	558 (0.3)	570 (0.6)	12* (0.3)
Nonwords	553 (0.3)	569 (0.8)	16* (0.5)

Note: Statistical significance is indicated with an asterisk (*)

Table 6

Mean naming latencies (in ms) and percentages of errors (within parentheses) associated with each experimental condition in Experiment 3.

	Priming Condition		
Type of Primes	Onset-related	Unrelated	MOPE
High Frequency	579 (0.8)	589 (0.3)	10* (-0.5)
Nonwords	553 (0.5)	569 (1.1)	13* (0.6)
Cons. Strings	588 (0.7)	590 (0.7)	2 (0.0)

Note: Statistical significance is indicated with an asterisk (*); Cons. Strings, Consonantal Strings.

Table 7

Mean naming latencies (in ms) and percentages of errors (within parentheses) associated with each experimental condition in Experiment 4.

	Priming Condition		
Type of Primes	Onset-related	Unrelated	MOPE
High Frequency	561 (0.0)	573 (0.3)	12* (0.3)
Cons. Strings	572 (0.3)	571 (0.4)	-1 (0.1)

Note: Statistical significance is indicated with an asterisk (*); Cons. Strings, Consonantal Strings.