# Words matter more than morphemes: An investigation of masked priming effects with complex words and non-words

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Two morphologically related words sharing the same stem usually share, at least partly, form and meaning. Our study aims to explore the extent to which bound-stem words, e.g. *facteur – facture* 'postman – bill', whose stems do not surface as free lexical items, are accessed through their word-form. Five visual masked priming experiments with French stimuli were conducted: Exp. 1 demonstrated that words sharing the same bound-stem primed each other and this effect differed from orthographic controls. Exp. 2 showed that both bound-stems presented in isolation (e.g. *fact-*) and their orthographic controls (e.g. *bact*) facilitated target processing (e.g. *facture*), suggesting the presence of formal effects. Exp. 3 revealed that when complex word primes (e.g. *facteur*) were directly compared to bound-stem primes (e.g. *fact-*) only the former produced priming effects. Finally, Exp. 4 and 5 explored the effect of non-words made of the illegal combination of a bound-stem and an existing/non existing suffix (e.g. *factier*/*factape*). While in Exp. 4 only constructed word primes facilitated target processing, Exp. 5 demonstrated that the effects observed using non-word primes were formal in nature since it did not matter whether the suffix was an existing one or not. Taken together, these results suggest that during the early stages of processing, bound-stem words are not decomposed but accessed through their word-form. They also contribute to distinguishing between morphological and formal/perceptual effects, which occur independently of factors such as lexicality of primes or their morphological structure, and that consequently cannot be interpreted in morphological terms. Our results corroborate an account of morphological effects based on abstract morphological representations organised paradigmatically, such as the one presented in the supra-lexical model (Giraudo & Grainger 2001), or the *lexomes* account recently presented by Baayen *et al.* (2015).

Keywords: masked morphological priming, paradigmatic morphology, bound-stem words, interference, prime lexicality, lexical decision task, formal effects.

## *1. Introduction*

Thirty years of investigations in the domain of psycholinguistic research have assigned a specific role to morphology in the mental lexicon. Indeed, the relevance of morphemes during reading and the

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earliness of morphological effects during lexical access have been broadly demonstrated, suggesting that morphology is coded within the mental lexicon. Many experimental studies have used the masked priming technique to examine the influence of morphologically related stimuli (both words and non-words) used as primes, on target word recognition. These studies systematically found very robust positive priming effects: across different languages bearing various morphological characteristics, and using multiple control priming conditions (unrelated but also orthographic/phonological and semantic controls in order to neutralize any interference effect), it has been shown that two morphologically related words prime each other (e.g. Arabic: Boudelaa & Marslen-Wilson 2001; Basque: Duñabeitia *et al.* 2009; German and Dutch: Drews & Zwitserlood 1995; French: Giraudo & Grainger 2000). The fundamental question concerning the nature and role of morphology within the mental lexicon led to two opposite hypotheses, as far as processing is concerned: either morphemic representations stand as access units to word representations (exemplified in the interactive activation model developed by Taft 1994), or more central units, at the interface of formal and meaning levels, organize word representations in morphological families (as proposed in Giraudo & Grainger's 2000 supralexical model).

These alternative explanations of morphological processing have been in competition until 2003-2005, when experimental research began to focus on surface characteristics of word structure and its involvement in the processes underlying early word recognition, such as those present in masked priming protocols. More precisely, several authors manipulated words and nonwords presenting morphemes at their surface: words such as *corner* or *baguette* 'baguette' that are not morphologically complex, but can be split into two parts mimicking two distinct morphemes (i.e. *corn-er* and *bagu-ette*), as well as nonwords created from the combination of two morphemes such as *sport-ation* were selected as primes. For example, Longtin *et al.* (2003) examined the priming effect induced by pseudo-derived words such as *baguette* on the recognition of word targets such as *bague* 'ring'. They found that relative to unrelated control conditions (e.g. *myrtille-bague* 'blueberry'-'ring'), a pseudo-morphological relationship between prime and target pairs (e.g. *baguette-bague*) induced priming effects whose magnitude was comparable to the effect produced by morphologically related prime-target pairs (e.g. *gaufrette-gaufre 'little waffle'-waffle'*). More importantly for the interpretation of the observed data, it has been found that word pairs overlapping only orthographically, i.e. presenting no surface morphemes, e.g. *abricot-abri* 'apricot'-'shelter' did not lead to significant priming effects. Longtin & Meunier (2005) showed that this pattern of results could be extended to nonword morphological primes (e.g. *rapidifier* that can be split into two morphemes, the stem *rapid-* and the suffix *–ifier*) which were shown to facilitate recognition of their word target (e.g. *rapide* 'fast'), while orthographic primes (e.g. *rapiduit* in which *–uit* does not correspond to a suffix in French) did not facilitate target recognition (e.g. *rapide* 'fast'). These findings have been broadly replicated in several languages (e.g. English: Rastle e al. 2004; Dutch and French: Diependaele *et al.* 2005; Spanish and Basque: Duñabeitia *et al.* 2007; Russian: Kazanina 2011; Greek: Orfanidou *et al.* 2011; Italian: Crepaldi *et al.* 2015) and led the authors to posit that an early mechanism of morphological decomposition based on orthographic analysis, operates at a sublexical level (see Rastle & Davis 2004). At the same time, data from inflected words showing genuine morphological effects impossible to attribute to orthographic overlap (Pastizzo & Feldman 2002), forced the proponents of the decompositional account to revise the strong sublexical hypothesis. Pastizzo & Feldman (2002), replicated by Crepaldi *et al.* (2010), demonstrated that allomorphs (e.g. *fell*) for which the decomposition of the surface form is not relevant in order to recover the stem, primed their verbal base (e.g. *fall*) more than orthographically matched (e.g. *fill*) and unrelated control words (e.g. *hope*) did. Crepaldi *et al.* (2010) therefore proposed two decompositional levels of morphological processing, instead of one (in the initial form of the approach, e.g. Rastle & Davis 2004), in order to account for: (1) surface morphological priming, which is considered to spring from a morpho-orthographic level proceeding sublexically, and (2) inflectional priming, coming from a morpho-semantic level operating at a more central locus within the mental lexicon. However, one can easily observe that both levels still contain morphemes, consequently making the strong assumption that our cognitive system only codes the syntagmatic dimension of complex words, leaving out their paradigmatic dimension. Demonstration for the influence of the lexical environment of the word-to-identify is nevertheless very rich: family size, cumulated frequency or orthographic neighborhood effects abound in the experimental literature (see Baayen 2014 for a review). Such effects discredit the decompositional nature of the second level of morphological processing in the Crepaldi *et al.* (2010) account, a level that should not be sensitive to the above effects. Contrary to this morphemic view, an upper level containing abstract morphological representations organising the lexicon in terms of morphological families has been already proposed by Giraudo & Grainger (2001).

The concept of "lexomes" recently introduced by Baayen *et al.* (2015) as well as Baayen *et al.* (2016), corresponds to abstract morphological representations organised paradigmatically. Lexomes are defined as pivotal units mediating between form and meaning while contributing to meaning, in conjunction with all other lexomes. Far from corresponding to decomposed sub-parts of words, lexomes capture systematic paradigmatic relationships between sets of words.

The present paper focuses on a category of complex words for which the appreciation of form-meaning overlap can only be the product of paradigmatic relationships between sets of words, i.e. bound stem words. Consider for instance the word *viral,* composed with the bound stem *vir-,* also present in *virus*, *virulent*, *virulence*, *virology* and *virologist*. A bound morpheme such as *vir-* does not have a meaning of its own, consequently it possesses zero semantic interpretability when presented in isolation. As suggested by Booij (2015: 5), regarding the holistic properties of morphological constructions, it is the constructional schema as a whole (e.g. *vir-*), in combination with a suffix (e.g. *–al*), that evokes the meaning. From this point of view, words constructed with bound morphemes are most likely to be processed holistically and are not comparable to free stem words like *singer* for which at least one morpheme, i.e. *sing*, is understandable, since it exists as a free-standing word.

The question of the lexicality of the primes is of interest here, as we know that items that are not coded within the orthographic lexicon induce less interference than word primes in processing terms (Norris & Kinoshita 2008), which means that a bound-stem presented in isolation, i.e. not as part of a word, will probably induce more facilitation (or less inhibition) than a word prime. This prime lexicality effect is demonstrated in several studies. For example Forster & Veres (1998) failed to find any priming with word primes when the nonword distractors were very close to a particular word (e.g. *univorse*), but priming in the masked condition was restored when more distant nonword distractors were used (e.g. *anivorse*). The prime lexicality effect is closely related to competition. For instance, in an interactive activation model (McClelland & Rumelhart 1981), this effect could be modelled either by decreasing the strength of lexical competition or by changing the decision criterion from local to global activation, as Forster & Veres remark (1998). We also wish to underline that the inhibition due to orthographic similarity between non-morphologically related words (e.g. between *mûrir* 'ripen' and the target *mural* 'wall adj.') in Grainger *et al.* (1991) constitutes one of the bases for the supra-lexical logic of the model presented by Giraudo & Grainger

(2001), which also attributes an important role to frequency. To sum up, it is clear that a bound-stem presents two important differences compared to a stem such as *sing*: it is not a word and, as such, it has no lexical frequency, it will thus not be able to induce inhibition similar to that of words.

The difference between free vs. bound-stems has been studied by psycholinguists, mainly with the goal of determining the role of semantic factors in morphological processing, given that bound stem words are considered as less semantically transparent than free stem words. Several studies have shown that processing of free and bound-stems may differ but they both produce significant priming effects (e.g. Forster & Azuma 2000; Pastizzo & Feldman 2004) suggesting that morphological priming effects are not directly constrained by semantic similarity between prime and target.

Taft & Kougious (2004) reported a masked priming experiment demonstrating facilitation for the semantically related pairs sharing a bound stem (e.g. *virus-viral*), but not for those that were semantically unrelated (e.g. *future-futile*). These data have been interpreted as reflecting higher effects of morphological processing that might operate at a more central level within the mental lexicon, without nevertheless calling into question the validity of the morphological decomposition mechanism.

Besides the matter of the influence of semantic factors during the early stages of processing complex words, bound-stem forms face another difficulty in terms of their surface analysis: namely, they are difficult to be segmented into morphemes. Consequently, the two accounts presented above give rise to different predictions: the morpheme-based approach predicts morphological priming effects between derivations (e.g. *virus-viral*) as well as between the base and its derivation (e.g. *vir-viral*), since both are decomposable; according to the supralexical approach, although members of the morphological family are linked together by virtue of their common base, the fact that the base of bound-stem words is not represented at the word-form level – given that it doesn't exist as a free lexical item – gives rise to the following prediction: priming effects should occur only between related derived words, and not when a bound-stem (e.g. *vir-*) is used as prime. The existence of abstract morphemic units in the supralexical account is determined by the recurrence of formal and semantic overlap (in various degrees) between word forms, and not by their surface morphological decomposability, as in the sublexical account.

## *2. Experimental part*

### *2.1. Experiment 1: Word primes*

The first experiment explores morphological priming effects using suffixed French words composed with bound-stems. These words are usually less semantically transparent than those created with a free-stem because their base is not a free-standing item. For instance, in the word *sécateur* ('shears'), the bound-stem *sec*- does not have any clear meaning for the standard reader, whereas the suffix *-(at)eur* is employed to form nouns in French. The stem *sec-* forms numerous morphologically complex words: *sécateur, sécabilité, secant(e), sécable, insécable, secteur, section, sectile, sectoriel, sectoriser, sectorisation, sectionner, sectionnement, sectionnaire, sectionneur, bissecteur, bisection, intersection*. In this case, morphological links structuring the members of the morphological family around the stem *sec-* do not depend on form and meaning of the base, but rather on formal and semantic overlap shared by the members of the family, which are all related to the idea of 'cutting', in various degrees.

#### 2.1.1. Participants

Thirty-three psychology students at the University of Provence (France) participated in the Experiment. In this and the following experiments all participants were native speakers of French, came from the same university and reported normal or corrected-to-normal vision.

#### 2.1.2. Stimuli

Thirty suffixed words composed with a bound-stem (e.g. *facture*) were selected as targets. Each target word was tested in three priming conditions defining the three levels of the Prime type factor (morphologically related suffixed word, orthographically related simple word and unrelated control). Thus each target was primed by the following word primes: (1) a morphologically related suffixed word sharing the same bound-stem (e.g. *<u>fact</u>eur-<u>fact</u>ure*); (2) an orthographically related simple word sharing the same initial letter sequence with the target (e.g. *<u>fac</u>étie-<u>fact</u>ure, fac-* in *facétie* is not a bound or free stem) and (3) an unrelated word (e.g. *schéma-<u>fact</u>ure*). Targets were 7.87 letter long on average and primes 7.58 letters long. Targets had an average printed frequency of 7.05 occ./million. Primes were matched in surface frequency and had an average frequency of 11.88 occ./million. Prime-target pairings were counterbalanced across three experimental lists associated with three independent groups of participants, such that each participant was tested in all three priming conditions but saw a given target word only once. This procedure has been followed in all the experiments presented here. Thirty morphologically complex non-words resembling to suffixed words (e.g. *ortier* where *ort-* is not a root in French but *-ier* is a suffix) were added for the purposes of the lexical decision task. The same were used in all the experiments presented here. Each pseudo-word target was primed by either a related word sharing the same suffix (e.g. *glacier-ortier*) or an unrelated word (e.g. *biscuit-ortier*).

2.1.3. Apparatus and procedure

The masked priming procedure was used (Forster & Forster 2003). Each trial consisted of the following sequence of three stimuli: A forward pattern mask composed of hash marks (#) presented for 500 ms, followed by the prime-stimulus presented for 57 ms, which in turn was immediately replaced by the target string (word or non-word) which remained on the screen until participants responded. Primes were presented in upper case and targets in lower case (with the necessary accents in French). The pattern mask was of the same length as the prime-word. Participants were seated 50 cm from the computer screen and they were instructed to respond as rapidly and accurately as possible whether the letter string in lower case was or was not a French word. Participants responded "yes" by pressing one of two response buttons with the forefinger of their preferred hand and "no" by pressing the other response button with the forefinger of the other hand. Participants were not informed of the presence of prime-words. After 20 practice trials, participants received the 60 experimental trials in one block. This procedure was common to the five experiments presented here.

2.1.4. Results

Correct response times (RTs) were averaged across participants after excluding outliers (RTs >1500ms, 0.77% of the data). Results are presented in Table 1. An ANOVA was performed on the data with prime type factor (morphologically related, orthographic and unrelated controls) as a within-participant factor. List was included as a between-participant factor in order to extract any variance associated with this variable. A Latin Square design was used in the present and following experiments. Therefore, as recommended by Raaijmakers et al. (1999), we did not perform separate subject and item analyses, but only an F1 statistical test.

**Table 1.** Latency and error data (by subjects) for Experiment 1 (word primes). U = Unrelated; O = orthographic; D = derived primes

| | Derived word | Orthographic control | Unrelated |
|---|---|---|---|
| prime | FACTEUR | FACETIE | SCHÉMA |
| Target | facture | facture | facture |
| RTs (in ms) | 693 | 728 | 729 |
| % of errors | 15.4 | 14.5 | 16.4 |
| Net priming effects | | | |
| U – D | 36* | | |
| U – O | 1 | | |
| O – D | 35* | | |

There was a significant effect of the prime type factor (F1(2,60) = 7.36, p < .003). Planned comparisons showed a significant priming effect of morphological primes relative to both orthographic and unrelated primes (F1(1,30) = 8.95, p < .01 and F1(1,30) = 11.27, p< .005). Orthographic primes did not differ significantly from unrelated primes (F1 < 1). An analysis of the error rates showed no main effect.

The data of Exp.1 reveal that relative to unrelated primes, only derived primes produced significant priming effects on target recognition, while simple overlapping form between prime and target was not sufficient to induce effects. This finding replicates those of Giraudo & Grainger (2001) with free-stem primes, showing that only true derived word primes (e.g. *laitage* 'dairy' - *laitier* 'milkman') were able to facilitate processing, whereas morphologically simple primes containing a pseudo-free-stem (e.g. *laitue* 'lettuce'- *laitier* 'milkman') did not influence performances relative to an unrelated prime condition; they also underline the need to use orthographic controls in order to separate morphological from orthographic priming effects.

While this first experiment stresses the importance of having the entire bound-stem within the prime in order to enable priming effects, it does not inform us about how bound-stem words are processed: are they analysed in terms of stem + affix or as a whole? The aim of Exp. 2 was to test the effect of bound-stems presented in isolation (i.e. deprived from any affix, from now on 'bare bound-stems'): if bound-stem words are decomposed into stem + affix during the very first stages of lexical access, constructed primes should induce facilitation relative to both orthographic and unrelated control conditions.

*2.2. Experiment 2: Non-word primes*

2.2.1. Participants

Thirty-six students participated in the experiment. They were from the same pool as those of Exp. 1, but they were not the same.

2.2.2. Stimuli

The target words were the same as those used in Exp. 1. Each target word was tested in three conditions defining the three levels of the prime type factor ('bare bound-stem', orthographic control and unrelated prime) and was thus primed by the following non-word primes: (1) its 'bare bound-stem', e.g. *fact-facture* 'bill'; (2) an orthographic control differing from one letter with the bound-stem, e.g. *bact-facture* and (3) an unrelated prime, e.g. *sché-facture*. Primes were matched in number of letters and were 4 letters long.

2.2.3 Results

Correct RTs were treated in the same way as in the previous experiment: outliers represented 0.43% of the data and the results are presented in Table 2. An ANOVA was performed, with prime type (morphologically related, orthographic and unrelated controls) as a within-participant factor, and list as a between-participant factor.

**Table 2.** Latency and error data (by subjects) for Experiment 2 (non-word primes). U = Unrelated; O = orthographic; BS = bound-stem

| | Bound-stem | Orthographic control | Unrelated unit |
|---|---|---|---|
| prime | FACT | BACT | SCHÉ |
| Target | facture | facture | facture |
| RTs (in ms) | 750 | 753 | 778 |
| % of errors | 12.5 | 14.4 | 11.9 |
| Net priming effects | | | |
| U – BS | 28* | | |
| U – O | 25 | | |
| O – BS | 3 | | |

The effect of the prime type factor approached significance ($F1(2,66) = 2.87$, $p = .06$) and planned comparisons revealed that this was because only 'bare bound-stem' primes produced significantly shorter reaction times ($F1(1,33) = 5.79$, $p < .025$) relative to the unrelated baseline. The 25 ms facilitation due to orthographic primes did not reach significance relative to unrelated primes ($F1(1,33) = 3.0$, $p = .09$), however this condition did not differ significantly from 'bare bound-stem' primes (F1< 1). An analysis of the error rates showed no main effect.

Despite the fact that only 'bare bound-stem' primes gave rise to significant effects, the 25ms non-significant facilitation induced by orthographic controls could be an indicator for formal effects. Exp. 3 was designed in order to elucidate this question.

### *2.3. Experiment 3: Word and non-word primes*

#### 2.3.1. Participants

Thirty different students from the same pool participated in the experiment.

#### 2.3.2. Stimuli

The target words were the same as in Exp. 1. Each target was tested in three priming conditions that combined Exp.'s 1 morphological and unrelated conditions to Exp.'s 2 bound-stem priming conditions. Each target was thus preceded by: (1) a morphologically related suffixed word constructed with the same bound-stem, e.g. *facteur* 'postman' - *facture* 'bill'; (2) its 'bare bound-stem', e.g. *fact-facture*; (3) an unrelated control, e.g. *schéma-facture*. Primes used in (1) and (3) were the same as those used in Experiment 1 and primes used in (2) were identical to those of Experiment 2.

#### 2.3.3. Results

Correct RTs were treated in the same way as in the previous experiment: outliers represented 1.76 % of the data and the results are presented in Table 3. An ANOVA was performed, with prime type (derived word, 'bare bound-stem' and unrelated control) as a within-participant factor, and list as a between-participant factor.

**Table 3.** Latency and error data (by subjects) for Experiment 3 (word and non-word primes). U = Unrelated; BS = bound-stem; D = derived

| | Derived word | Bound-stem | Unrelated |
|---|---|---|---|
| prime | FACTEUR | FACT | SCHÉMA |
| Target | facture | facture | facture |
| Rts (in ms) | 743 | 758 | 776 |
| % of errors | 14.0 | 15.0 | 17.3 |
| Net priming effects | | | |
| U – D | 33* | | |
| U – Bs | 18 | | |
| BS – D | 15 | | |

The effect of the prime type factor was significant ($F1(2,54) = 4.6$, $p < .025$) and planned comparisons revealed that morphologically derived primes produced shorter reaction times compared to unrelated primes ($F1(1,27) = 8.27$, $p < .01$). RTs induced by morphologically derived primes did not differ significantly from RTs in the 'bare bound-stem' conditions ($F1(1,27) = 1.84$, $p > 10$). However, 'bare bound-stem' primes did not induce any significant effect when compared to unrelated primes ($F1(1,27) = 3.21$, $p = 08$). An analysis of the error rates showed no main effect.

We are not going to present here the implications of the results of this experiment, which will be extensively discussed in the general discussion. One can nevertheless remark that the main difference between Exp. 1, on one hand, and Exp. 2 and 3 on the other hand, is the lexical status of the primes: In Exp. 1, all the critical primes were existing words (e.g. *facteur*, *facétie*) and the respective effect of each related priming condition was compared to an unrelated baseline constituted of words (e.g. *schéma*). In Exp.2, 'bare bound-stems', e.g. *fact*, which aren't words, and consequently are not coded in the orthographic lexicon, were manipulated and compared to orthographic, e.g. *bact*, and unrelated, e.g. *sché*, conditions corresponding to non-words. Finally, in Exp. 3, derived word primes were compared to 'bare bound-stems' and to unrelated word primes. We can then formulate the hypothesis that the facilitation induced by 'bare bound-stems' in Exp. 2 and 3, and in particular the +28 ms significant effect found in Exp. 2, can be explained on the basis of the non-lexicality of the primes used in these experiments, given that non existing words (non-words) are items which are not coded within the orthographic lexicon, thus inducing less interference than orthographic word primes as we saw in the introduction. An additional difference is that orthographic word controls used in Exp. 1 did not systematically contain a pseudo bound-stem, while in Exp. 2 and 3, complete bound-stems (e.g. *fact*) were used. Exp. 4 is designed as a combination of Exp. 1 and 3, in order to explore the possible interference effects.

### *2.4. Experiment 4: Word and non-word primes*

#### 2.4.1. Participants

Twenty-seven different students, from the same pool and with the same characteristics participated in the experiment.

#### 2.4.2. Stimuli

The materials were the same as in Exp. 1 except for the orthographic control condition which was replaced by a non-word condition, formed by the illegal combination of a bound-stem (the same as the target word's bound-stem) and a suffix. Each target was thus preceded by: (1) a morphologically related word with the same bound-stem (e.g. *facteur-facture*); (2) a non-word made of the same bound-stem and a different suffix (e.g. *factier-facture* where *fact-* and *-ier* correspond to existing morphemes in French) (3) an unrelated word (e.g. *schéma-facture*).

2.4.3. Results

Correct RTs were treated in the same way as in the previous experiment. Four participants were eliminated from the analyses because of high error rates (>30%) and there were no outliers. Results are presented in Table 3. An ANOVA was performed, with prime type (derived word, non-word made of the same bound-stem + different suffix, unrelated control) as a within-participant factor, and list as a between-participant factor.

**Table 4.** Latency and error data (by subjects) for Experiment 4 (word and non-word primes). U = Unrelated; DPs = derived Non-word; D = derived

| | Derived word | Derived non-word | Unrelated |
|---|---|---|---|
| prime | FACTEUR | FACTIER | SCHÉMA |
| Target | facture | facture | facture |
| RTs (in ms) | 663 | 688 | 703 |
| % of errors | 6.95 | 9.13 | 8.26 |
| Net priming effects | | | |
| U – D | 40* | | |
| U – DPs | 15 | | |
| DPs – D | 25* | | |

There was a significant effect of the prime type factor ($F1(2,44) = 6.68$, $p < .005$). Planned comparisons revealed that only related word primes produced significantly shorter reaction times than unrelated primes ($F1(1,22) = 16.47$, $p < .001$). The morphologically structured non-word condition (non-word made of the same bound-stem + different suffix), induced RTs shorter than the unrelated control condition but did not significantly differ from it ($F1(1,22) = 1.74$, $p > .10$). Importantly, related word primes differ significantly from non-word primes ($F1(1,22) = 4.30$, $p < .05$). An analysis of the error rates showed no main effect.

These data seem very clear: priming effects induced by derived word primes differed significantly from the effects produced by non-word primes. Contrary to the previous experiments, all the non-words used here contained an identical to the target bound-stem (plus an existing suffix): however, this was not sufficient to induce significant priming. Moreover, the presence of an inappropriate, yet existing, suffix has reduced the positive formal effects observed in Exp. 2 and 3.

The last experiment seeks to establish if the positive – though not always significant – effects induced by non-word primes are due to the morphological structure of these primes or merely to formal similarities in prime-target pairs.

### *2.5. Experiment 5: Non-word primes*

#### 2.5.1. Participants

Twenty-seven students participated in the experiment.

#### 2.5.2. Stimuli

The materials were the same as in Exp. 4, but here morphologically related word primes were replaced by non-word primes constructed with a bound-stem and a final letter sequence that does not correspond to any suffix in French. The following three priming conditions defined the three levels of the prime type factor: (1) the 'complex non-word' condition, i.e. a non-word formed by a bound-stem and an existing suffix, e.g. *factier-facture* 'bill', where *fact-* and *-ier* correspond to existing morphemes in French; (2) the simple non-word condition, i.e. a non-word formed by a bound-stem plus a non-morphological ending, e.g. *factape-facture* in which *-ape* is not a suffix in French; (3) an unrelated non-word, e.g. *schima-facture*.

#### 2.5.3. Results

Correct RTs were treated in the same way as in the previous experiments. Four participants were eliminated from the analyses because of high error rates (>30%) and there were no outliers. Results are presented in Table 5. An ANOVA was performed, with prime type (complex non-word, simple non-word, unrelated control) as a within-participant factor, and list as a between-participant factor.

**Table 5.** Latency and error data (by subjects) for Experiment 5 (non-word primes). U = Unrelated; SPs = simple non-word; DPs = derived Non-word

| | Derived non-word | Simple non-word | Unrelated non-word |
|---|---|---|---|
| prime | FACTIER | FACTAPE | SCHIMA |
| Target | facture | facture | facture |
| RTs (in ms) | 633 | 637 | 664 |
| % of errors | 6.82 | 6.08 | 10.43 |
| Net priming effects | | | |
| U – DPs | 31* | | |
| U – SPs | 27* | | |
| SPs – DPs | 4 | | |

There was a significant main effect of prime type factor (F1(2,44) = 4.85, p < .025). Planned comparisons revealed that both complex and simple non-word primes produced significant priming effects (F1(1,22) = 8.08, p < .01 and F1(1,22) = 5.63, p < .05 respectively). The complex non-word condition did not differ from the simple non-word condition (F1<1). Analysis of error rates revealed a tendency to significance of the prime type factor (F1(2,44) = 2.94, p = .89) and planned comparisons showed that the simple non-word prime condition produced significantly less errors than the unrelated non-word condition (F1(1,22) = 5.41, p < .05). However, the complex and the simple non-word prime conditions didn't differ from each other F1(1,22) = 1.15, p > .10), neither did the complex and the unrelated non-word prime conditions (F1(1,22) = 1.86, p > .10).

The direct comparison of complex non-word primes to simple non-word primes reveals that both prime types were able to facilitate target recognition. We can thus state that, contrary to Exp. 4, the nature of primes (all of them nonword primes) did not generate interference, but instead facilitated target processing. Moreover, the effects produced by complex primes (e.g. *factier*) did not differ from those induced by simple primes (e.g. *factape*), rejecting thus any interpretation in terms of pre-lexical morphological decomposition. This result is not in accordance with those found by Longtin & Meunier (2005), as we shall see in the general discussion.

## *3. General discussion*

### *3.1. Bound-stem priming effects*

This paper examines morphological priming induced by derived primes constructed with bound-stems, according to the following rationale: in Exp. 1, morphological effects were evaluated relative to an orthographic priming condition that enabled us to control the respective part of morphology and form. Results demonstrated clear morphological priming effects that cannot be reduced to formal overlap between prime and target pairs, since only derived primes significantly facilitated target recognition relative to both the unrelated baseline and their orthographic controls. In Exp. 2, we sought to determine if the morphological priming effect was triggered by the activation of bound-stems as independent units, coded in long-term memory. For this purpose, we manipulated 'bare bound-stem' primes (i.e. bound-stems deprived of suffix, e.g. *terr* from *terreur*) and we compared their effect on the recognition of targets (e.g. *terreur*) to the effect induced by appropriate orthographic controls (e.g. *tarr*). Results showed that both categories of primes produced equivalent facilitation on target processing relative to the unrelated baseline condition, suggesting that formal factors mainly underlie the priming pattern found in this experiment. In order to specify the role of 'non-embedded' morphology relative to the facilitation that constructed word primes induce, in Exp. 3 we compared the effect of 'bare bound-stem' primes (e.g. *terr*) relative to that of derived word primes (e.g. *terrible*) on recognition of constructed targets (e.g. *terreur*). If a bound-stem prime presented in isolation triggers the activation of a morphemic representation during lexical access, it should produce an effect equivalent to that of the derived word prime, according to the claims of the decompositional account. Results demonstrated that only constructed word primes produced significant effect (33 ms) on processing the target relative to the unrelated condition, suggesting that it takes a real word to induce priming. This is the basic outcome of the experiments presented here. However, one can remark that, in Exp. 3, derived word conditions were not statistically different from 'bare bound-stem' ones, and that this is a result compatible with the decompositional account, given that these two conditions are equally 'decomposable'. Nevertheless, given that 'bare bound-stem' priming failed to reach significance in Exp. 3, it would be more reasonable to interpret the lack of significant difference between 'bare bound-stem' primes and derived word primes in terms of formal rather than morphological processing. This is especially true in the context of the experimental technique used here, acknowledged to be sensitive to orthographic factors (Kinoshita & Lupker 2003), particularly when combined with the lexical decision task (Norris & Kinoshita 2008; see also Baayen 2014).

However, an important difference between Exp. 1, on the one hand, and Exp. 2 and 3, on the other hand, should be emphasised: while in Exp. 1 morphological conditions induce effects that significantly differ from both orthographic and unrelated controls, in the two following experiments the morphological conditions, whether they contain 'bare bound-stems' (Exp. 2) or derived words (Exp. 3), induce significant effects only with respect to unrelated controls. Given that the main difference between the first experiment and the following two is the lexicality of the primes, we can take this pattern of RTs as an indication of interference (or lack of it) between lexical representations: non-words, by definition non-coded in the orthographic lexicon and deprived of lexical representation,[1] induce less interference than existing words during processing the target (Grainger *et al.* 1991; Forster & Veres 1998; Norris & Kinoshita 2008). This could explain why formal priming effects emerged more saliently in Exp. 2 than in Exp. 1, where orthographic word primes were used. However, we cannot validate or refute this hypothesis on the basis of these experiments (Exp. 1, 2 and 3), precisely because of the difference in nature of the stimuli: the orthographic word controls (e.g. *sécréter* for the target *sécateur*) used in Exp. 1 did not systematically contain a 'pseudo-bound-stem', while in Exp. 2 and 3 complete bound-stems ('bare bound-stems') were used (e.g. *terr, fact, sec*), and formal overlap between prime and target pairs was thus greater in Exp. 2 and 3 than in Exp. 1.

The two last experiments were designed in order to test the interference hypothesis relative to prime lexicality. Exp. 4 demonstrated that constructed word primes (e.g. *facteur*) significantly reduced target recognition RTs, whereas derived non-word primes (e.g. *factier*) did not. Moreover, derived word primes produced shorter RTs than both derived non-word primes and unrelated primes, while derived non-word primes did not differ from the unrelated control condition. Finally, in Exp. 5, targets were all words and primes were all non-words: the first type of non-word prime was constructed with an existing stem and an existing suffix (e.g. *secal*) and the second one contained an existing stem and a non-existing suffix (e.g. *secaul*, or *factape*). Results showed that both types of orthographically related non-word primes facilitated target word recognition relative to an unrelated non-word baseline (e.g. *schima*), without significantly differing between them, independently of their 'morphological' status (decomposable, e.g. *secal*, versus non-decomposable, e.g. *secaul*). This result, exactly as those of Exp. 1 compared to the following two, suggests that formal priming effects emerge more saliently when non-words are used. Moreover, the significant priming effects of Exp. 2 and 5 are rather formal in nature, given that 'bare bound-stem' primes (e.g. *fact*, Exp. 2) as well as derived non-word primes (e.g. *factape*, Exp. 5) did not differ from their orthographic controls (e.g. *bact* and *factier* respectively). We can thus state that in the experiments presented here, only existing derived words managed to induce morphological priming on the recognition of bound-stem words, beyond and above formal factors and within a technique and a task (masked priming with lexical decision) sensitive to form overlap effects (Norris & Kinoshita 2008).

As far as non-word primes are concerned, not only the priming effects they induce are not statistically different from form overlap effects, but, as we demonstrated (Exp. 5), it doesn't matter whether the non-word is 'decomposable' (e.g. *secal*) or not (e.g. *secaul*): both non-word primes create equivalent facilitation on recognition of the target, regardless of whether they are morphologically structured or not. Therefore, the answer to the question related to the morphological or purely perceptive nature of some of our effects (Exp. 3 and 5), as well as in a considerable proportion of studies on morphological processing, is that the masked priming technique combined with the lexical decision task is probably the best way to obtain non-lexical effects exploiting the fact that 'orthographic information of prime and target will blur into one perceptual whole' (Baayen 2014: 2). Interpreting these non-lexical formal effects as morphological in nature constitutes an error, in our opinion, whether it is motivated within a decomposition approach (e.g. Crepaldi *et al.* 2010; Longtin & Meunier 2005), or any other account.

The results presented here, and particularly the results of Exp. 4 and 5, contradict those published by Longtin & Meunier (2005), using the same experimental conditions, where derived non-word primes systematically produce significant priming effects on target recognition relative to unrelated word controls, e.g. *rapidement* 'soon' and *rapidifier* equally prime the target *rapide* 'quick' (41* and 43* ms respectively, Exp.1). In the same study, non-morphological non-word primes (e.g. *rapiduit*) yield a + 29 ms non-significant difference. This pattern of results is taken by the authors as evidence for automatic and mandatory decomposition in French, given that decomposable primes (whether they are existing words or not) induce significant effects, whereas non-decomposable ones (e.g. *rapiduit*) do not. These results are clearly divergent from ours, which show that morphological priming with constructed words differs from what was demonstrated to be formal/perceptual in nature. Two factors can explain the discrepancies between the two studies: the type of unrelated controls and the type of word targets. Contrary to Longtin & Meunier (2005) who use exclusively base words as targets, we focused on bound-stem words and our targets were inevitably complex words instead of bases; furthermore, we examined priming effects relative to unrelated non-word primes (Exp. 2 and 5) instead of words in the Longtin & Meunier (2005) study. Longtin & Meunier's (2005) exclusive use of base words as targets is not without consequences within a technique created to study activation during automatic lexical processing: it may have led to an enhancement of the orthographic-perceptual processing, perceptible through the 29 ms of facilitation for *rapiduit*, which is surprisingly non-significant; a base word is by definition more frequent, and, consequently, is the easiest member of the paradigm to be activated, because of its relatively low activation threshold, due to its considerable residual activation (Voga & Giraudo 2009 for relevant French data). In French, free roots have a very high surface frequency, usually the highest among the members of their morphological family, whereas derived words constructed with a bound-stem have low surface frequencies (7.05 occ./million in our study vs. 82.4 occ./million in Longtin & Meunier) and, consequently, higher activation threshold.

Additionally, frequency may also lead to 'full' or 'partial' processing of the prime: as suggested by Masson and colleagues (Masson & Bodner 2003; Kliegl et al. 2010), word frequency may influence the magnitude of masked priming since "the greater difficulty associated with processing low frequency words means that subjects are more likely to recruit and use the prime event in their encoding of the target" (2003: 71). Our purpose here is not to review the rich literature related to behavioural research methods. Still we can formulate the hypothesis that in a number of masked priming studies, as well as in Longtin & Meunier (2005), taking 'the easiest member to activate' as target of the recognition may have led to a situation where formal effects are amplified, irrespective of the lexical[2] or morphological aspects of the primes. Conversely, in the five experiments presented here, activating derived targets having a middle surface frequency, though it may need more time[3] because a greater amount of activation is needed, enables us not only to circumvent this bias, but possibly to observe effects that would have been difficult to notice in a 'classic' base-word target design, where the dazzling ascent of the easiest family member to activate (i.e. base word) would have condemned them to obscurity.

*3.2. Implications for the representation of morphologically complex words*

Based on the above, it is evident that prelexical activation of surface morphemes, that constitutes the basis of the decompositional approach (e.g. Taft 1994; Rastle *et al.* 2004; Longtin & Meunier 2005; Crepaldi *et al.* 2010), cannot integrate the pattern of results presented here, which would be compatible with a model assuming more central morphological effects, taking place at the interface of word forms and concepts. This complex word recognition system would be based, in our view, on two facilitation springs: a) bottom-up excitation from a word-form level; and b) top-down facilitation from a supralexical level containing morphological representations (e.g. Giraudo & Grainger 2001). We consider this morphological level as an emergent level whose units are created during language acquisition and learning through the interactions between word forms and semantics. In other words, it translates the systematic co-occurrences of form and meaning defining morphology. As a consequence, this level should contain abstract base lexemes[4] or lexomes (as defined by Baayen et al., 2016) operating as indirect and direct connecting nodes for: 1) word forms belonging to the same morphological family (indirect) and 2) word forms and concepts (direct). This kind of organisation is also compatible with Corbin's view, according to which speakers will deduce the properties of the bound-stem from the constructed lexemes containing it and the RCM:[5]

> Speakers are likely to deduce the properties of *chanteur* from those of *chanter* and the relevant RCM to which the suffix *-eur* is associated, or those of *chanter* from the properties of *chanteur* and those of the RCM, whereas for *aviateur*, whose base *avi(er)* is not attested as a word, only the latter case can occur. But this is not a pertinent difference for the model of competence: for example, the fact that *vulnerer* is attested as a word in its own right (it is characterised as rare in R85)[6] does not guarantee that speakers learn it from its autonomous uses, they can perfectly acquire it from its use as a base for *vulnérable* and *vulnéraire* (Corbin 1987: 207).

The idea according to which morphological effects cannot be reduced to the activation of sublexical units (morphemes) has recently been expressed by some authors who assume a double representation of morphology: Diependaele *et al.* (2005) split the morphological level into two distinct components, but consider the two components as equivalent, since both contain units that correspond to concrete pieces of words (surface morphemes). Such an account cannot integrate the results presented here, showing that only whole-words (and not their parts) are able to trigger morphological effects, i.e. facilitation which is morphological in nature, instead of being formal and/or perceptual. Additionally, this modelling attempt, while moving in the right direction, fails to implement the simple fact that different locations in the model should imply different contents (e.g. Grainger & Jacobs 1996, for modelling lexical access).

A more general criticism is related to the questions raised as to the validity and usefulness of the morpheme as a theoretical construct (e.g. Stump 2001): as Baayen (2014) underlines, these questions have not entered into the awareness of most of the psycholinguistic community. Moreover, as the results of the five experiments presented here demonstrate, we can also wonder whether the validity of the morpheme as a functional construct is satisfactory, i.e. whether it enhances the psycholinguists' chances to look into the mental lexicon through morphological representation and processing. It seems to us that despite the huge amount of studies concluding in favour of various forms of automatic prelexical decomposition, the question related to morphological representation and processing of complex words has not received an adequate response, especially given the following experimental facts:

(1) Results issued from manipulating inflections refute the hypothesis of an automatic decomposition independent of lexical access, for both irregular inflections, as in English (Pastizzo & Feldman 2002; Crepaldi *et al.* 2010), and more regular ones, as in Greek (Voga *et al.* 2012).

(2) Results issued from protocols using a task different than lexical decision (Duñabeitia *et al.* 2011), or a variant of the forward masked priming paradigm (Feldman *et al.* 2009) cannot be integrated in an automatic decomposition account.

(3) Results from protocols examining variables extending beyond the word-form itself, i.e. relative to the paradigmatic organisation of the lexicon, e.g. the morphological family size found in many languages (e.g. De Jong *et al.* 2000), or variables relative to the complex set of activations and inhibitions during recognition of word stimuli, e.g. the pseudo-family size effect found in French (Voga & Giraudo 2009), stress the fact that morphological complexity is not reduced to a morpheme assembly, but manifests itself in mul-

tiple facets. Studying these facets imperatively suggest to implement, through experiments with native and non-native speakers, the paradigmatic structuring of the lexicon defined by Corbin (1987/1991) and Booij (2005).

(4) Various effects that are related to the manipulation of frequency in masked priming protocols, from surface frequencies (e.g. Giraudo & Grainger 2001) to prime and target relative frequencies (Voga & Giraudo 2009; Giraudo & Orihuela 2015, both for French; Voga *et al.* 2012 for Greek verbs), as well as the results of the experiments presented here, especially when considered in comparison to those found by, e.g. Longtin & Meunier (2005), point to the need to bear in mind certain facts about the masked priming protocol. First, it is sensitive to perceptual similarity between primes and targets, and, second, priming effects can be task-specific. For instance, they are present in a lexical decision task but absent in a same-different task (Kinoshita & Lupker 2003; Norris & Kinoshita 2008; see also Baayen 2014).

The last point requires a concluding remark. The fact that certain drawbacks of the masked priming experimental technique – with which a significant part of the morphological research in psycholinguistics has dealt over the last 20 years – may sometimes have led to interpretations neglecting some basic facts about this technique, should not be viewed as a problem inherent in the technique, but as a problem of lack of caution in interpreting the results. One of the aims of our study was precisely to highlight the great complexity induced by several intertwining factors on this type of protocol, e.g. lexicality of primes and targets, nature of controls, relative frequencies, as well as other types of relatedness described in recent studies (e.g. Pastizzo & Feldman 2009). This could lead us to re-consider the interpretation of some of the data provided by masked priming, a technique that still remains the only way to examine automatic lexical processing through behavioural measures with important samples of real world speakers.

*Appendix A. List of stimuli used in Experiment 1*

| Derived word primes | Orthographic controls | Unrelated primes | Targets |
|---|---|---|---|
| CHIRURGIE | CHIPOLATA | PHOSPHORE | chirurgien |
| EXTINCTION | EXTRÉMITÉ | DRAMATURGE | extincteur |
| TERRIBLE | TERRASSE | MONTAGNE | terreur |
| GÉNÉREUX | GENDARME | SCANDALE | générosité |
| RAMEAU | RAMPER | BREBIS | ramure |
| LIQUEUR | LICENCE | CAVERNE | liquide |
| ALLUSION | ALLUVION | TRIOMPHE | allusif |
| LOCUTEUR | LOCALITÉ | ANGUILLE | locution |
| ANXIEUX | ANCÊTRE | ESTOMAC | anxiété |
| MERCIER | MERCURE | CARAMEL | mercerie |
| AMIRAL | AMIDON | CHIFFRE | amirauté |
| ÉRUPTIF | ÉRUDIT | MORILLE | éruption |
| FACTEUR | FACÉTIE | SCHÉMA | facture |
| RIGIDE | RIGOLE | BEURRE | rigueur |
| SÉCATEUR | SÉCRÉTER | GANGSTER | sécable |
| NAUTIQUE | NARCISSE | ESQUIMAU | nautisme |
| EXPANSION | EXPÉDIENT | RÉFÉRENCE | expansif |
| PUDIQUE | PUDDING | TOMBOLA | pudeur |
| ADDITION | ADJECTIF | ÉLÉPHANT | additif |
| LÉGISLATION | LÉGIONNAIRE | CONTRETEMPS | législateur |
| AUTISME | AUTOCAR | GIROFLE | autiste |
| FUREUR | FUSAIN | CHAÎNE | furie |
| HORREUR | HORIZON | MÉDECIN | horrible |
| AMBITION | AMBASSADE | APPAREIL | ambitieux |
| VIOLINE | VIOLENT | CAPUCHE | violâtre |
| ARDEUR | ARGILE | MENTON | ardemment |
| MONITEUR | MONARQUE | BOUSSOLE | monitorat |
| CANDIDE | CANTINE | ÉCAILLE | candeur |
| AVIATION | AVANTAGE | MOLÉCULE | aviateur |
| INTUITIF | INTESTIN | PROVERBE | intuition |

*Appendix B. List of stimuli used in Experiment 2*

| Bound-stem primes | Orthographic controls | Unrelated primes | Targets |
|---|---|---|---|
| CHIRURG | CHIRORG | PHOSPH | chirurgien |
| EXTINCT | EXTONCT | DRAMAT | extincteur |
| TERR | TARR | MONTAG | terreur |
| GÉNÉR | VÉNÉR | SCAND | générosité |
| RAM | TAM | BREB | ramure |
| LIQU | LOQU | CAVER | liquide |
| ALLUS | ALLUV | TRIOMP | allusif |
| LOCUT | ROCUT | ANGU | locution |
| ANXI | ANLI | ESTOM | anxiété |
| MERC | MORC | CARAM | mercerie |
| AMIR | APIR | CHIF | amirauté |
| ÉRUPT | ÉLUPT | MORIL | éruption |
| FACT | BACT | SCHÉ | facture |
| RIGU | RAGU | BEUR | rigueur |
| SÉCA | LÉCA | GANGST | sécable |
| NAUT | NAUP | ESQUIM | nautisme |
| EXPANS | ERPANS | RÉFÉR | expansif |
| PUD | TUD | TOMBO | pudeur |
| ADDIT | ODDIT | ÉLÉPH | additif |
| LÉGISL | LEDISL | CONTR | législateur |
| AUT | AUP | GIROF | autiste |
| FUR | FIR | CHAÎN | furie |
| HORR | HARR | MÉDEC | horrible |
| AMBIT | AMPIT | APPAR | ambitieux |
| VIOL | BIOL | CAPUC | violâtre |
| ARD | ARV | MENTO | ardemment |
| MONIT | VONIT | BOUSS | monitorat |
| CAND | COND | ÉCAIR | candeur |
| AVIA | AGIA | MOLÉCE | aviateur |
| INTUIT | INVUIT | PROVE | intuition |

*Appendix C. List of stimuli used in Experiment 3*

| DERIVED WORD PRIMES | BOUND-STEM PRIMES | UNRELATED PRIMES | TARGETS |
|---|---|---|---|
| CHIRURGIE | CHIRURG | PHOSPHORE | chirurgien |
| EXTINCTION | EXTINCT | DRAMATURGE | extincteur |
| TERRIBLE | TERR | MONTAGNE | terreur |
| GÉNÉREUX | GÉNÉR | SCANDALE | générosité |
| RAMEAU | RAM | BREBIS | ramure |
| LIQUEUR | LIQU | CAVERNE | liquide |
| ALLUSION | ALLUS | TRIOMPHE | allusif |
| LOCUTEUR | LOCUT | ANGUILLE | locution |
| ANXIEUX | ANXI | ESTOMAC | anxiété |
| MERCIER | MERC | CARAMEL | mercerie |
| AMIRAL | AMIR | CHIFFRE | amirauté |
| ÉRUPTIF | ÉRUPT | MORILLE | éruption |
| FACTEUR | FACT | SCHÉMA | facture |
| RIGIDE | RIGU | BEURRE | rigueur |
| SÉCATEUR | SÉCA | GANGSTER | sécable |
| NAUTIQUE | NAUT | ESQUIMAU | nautisme |
| EXPANSION | EXPANS | RÉFÉRENCE | expansif |
| PUDIQUE | PUD | TOMBOLA | pudeur |
| ADDITION | ADDIT | ÉLÉPHANT | additif |
| LÉGISLATION | LÉGISL | CONTRETEMPS | législateur |
| AUTISME | AUT | GIROFLE | autiste |
| FUREUR | FUR | CHAÎNE | furie |
| HORREUR | HORR | MÉDECIN | horrible |
| AMBITION | AMBIT | APPAREIL | ambitieux |
| VIOLINE | VIOL | CAPUCHE | violâtre |
| ARDEUR | ARD | MENTON | ardemment |
| MONITEUR | MONIT | BOUSSOLE | monitorat |
| CANDIDE | CAND | ÉCAILLE | candeur |
| AVIATION | AVIA | MOLÉCULE | aviateur |
| INTUITIF | INTUIT | PROVERBE | intuition |

*Appendix D. List of stimuli used in Experiment 4*

| Derived word primes | Derived non-word primes | Unrelated primes | Targets |
|---|---|---|---|
| CHIRURGIE | CHIRURGION | PHOSPHORE | chirurgien |
| EXTINCTION | EXTINCTARD | DRAMATURGE | extincteur |
| TERRIBLE | TERRAGE | MONTAGNE | terreur |
| GÉNÉREUX | GÉNÉRAGE | SCANDALE | générosité |
| RAMEAU | RAMION | BREBIS | ramure |
| LIQUEUR | LIQUIF | CAVERNE | liquide |
| ALLUSION | ALLUSEUX | TRIOMPHE | allusif |
| LOCUTEUR | LOCUTIQUE | ANGUILLE | locution |
| ANXIEUX | ANXISME | ESTOMAC | anxiété |
| MERCIER | MERCINE | CARAMEL | mercerie |
| AMIRAL | AMITION | CHIFFRE | amirauté |
| ÉRUPTIF | ÉRUPTIDE | MORILLE | éruption |
| FACTEUR | FACTINE | SCHÉMA | facture |
| RIGIDE | RIGEAU | BEURRE | rigueur |
| SÉCATEUR | SÉCAL | GANGSTER | sécable |
| NAUTIQUE | NAUTEUR | ESQUIMAU | nautisme |
| EXPANSION | EXPANSIDE | RÉFÉRENCE | expansif |
| PUDIQUE | PUDION | TOMBOLA | pudeur |
| ADDITION | ADDITEUR | ÉLÉPHANT | additif |
| LÉGISLATION | LÉGISLATIDE | CONTRETEMPS | législateur |
| AUTISME | AUTEUX | GIROFLE | autiste |
| FUREUR | FUREUX | CHAÎNE | furie |
| HORREUR | HORRION | MÉDECIN | horrible |
| AMBITION | AMBITEUR | APPAREIL | ambitieux |
| VIOLINE | VIOLAL | CAPUCHE | violâtre |
| ARDEUR | ARDIEN | MENTON | ardemment |
| MONITEUR | MONITIEN | BOUSSOLE | monitorat |
| CANDIDE | CANDISME | ÉCAILLE | candeur |
| AVIATION | AVIATIEN | MOLÉCULE | aviateur |
| INTUITIF | INTUITAL | PROVERBE | intuition |

*Appendix E. List of stimuli used in Experiment 5*

| Complex non-words | Simple non-words | Unrelated non-words | Targets |
|---|---|---|---|
| CHIRURGION | CHIRURGAPE | PHOSPHARE | chirurgien |
| EXTINCTARD | EXTINCTUPE | DROMATURGE | extincteur |
| TERRAGE | TERROME | MOITAGNE | terreur |
| GÉNÉRAGE | GÉNÉROIE | STANDALE | générosité |
| RAMION | RAMORE | PREBIS | ramure |
| LIQUIF | LIQUEME | CALERNE | liquide |
| ALLUSEUX | ALLUSIPE | CRIOMPHE | allusif |
| LOCUTIQUE | LOCUTAPE | ANQUILLE | locution |
| ANXISME | ANXAME | ERTOMAC | anxiété |
| MERCINE | MERCONE | VARAMEL | mercerie |
| AMITION | AMIRUPE | CHOFFRE | amirauté |
| ÉRUPTIDE | ÉRUPTOS | MARILLE | éruption |
| FACTINE | FACTOPE | SCHAMA | facture |
| RIGEAU | RIGUME | KEURRE | rigueur |
| SÉCAL | SÉCAULE | DANGSTER | sécable |
| NAUTEUR | NAUTIME | ASQUIMAU | nautisme |
| EXPANSIDE | EXPANSUE | RÉBÉRENCE | expansif |
| PUDION | PUDORE | XOMBOLA | pudeur |
| ADDITEUR | ADDITOPE | OLÉPHANT | additif |
| LÉGISLATIDE | LÉGISLAPE | CANTRETEMPS | législateur |
| AUTEUX | AUTUIPE | GAROFLE | autiste |
| FUREUX | FURIVE | CHAÎPE | furie |
| HORRION | HORRAME | LÉDECIN | horrible |
| AMBITEUR | AMBITEPE | APPOREIL | ambitieux |
| VIOLAL | VIOLOLLE | TAPUCHE | violâtre |
| ARDIEN | ARDUPE | MENCON | ardemment |
| MONITIEN | MONITUE | LOUSSOLE | monitorat |
| CANDISME | CANDOPE | ÉCUILLE | candeur |
| AVIATIEN | AVIATODE | BOLÉCULE | aviateur |
| INTUITAL | INTUITES | PROVERSE | intuition |

## Notes

[1] This was not the case of *sec* 'dry'.
[2] As demonstrated by the pseudo-derivation effect, one of the bases of the decompositional account, where primes semantically unrelated to targets (e.g. *baguette* 'bread' – *bague* 'ring', in Longtin & Meunier 2005; *corner – corn* or *text – textile* in Rastle et al. 2004)
[3] We remark in fact that our participants responding to derived suffixed targets are not as quick as those in the Longtin & Meunier (2005) study responding to base-word targets.
[4] Some affixes could also be represented at this interface, as emergent units capturing the systematic correspondences between form and meaning related to the affix in question.
[5] Règles de Construction des Mots (RCM).
[6] *Le Grand Robert de la langue française: dictionnaire alphabétique et analogique de la langue française*, Paris, Dictionnaires Le Robert, 1985 [original edition 1958-1964; Supplement 1970, 2nd edition revised and enlarged by Alain Rey].

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