# Lexeme-Based Model vs. Morpheme-Based Model from Psycholinguistic Perspectives

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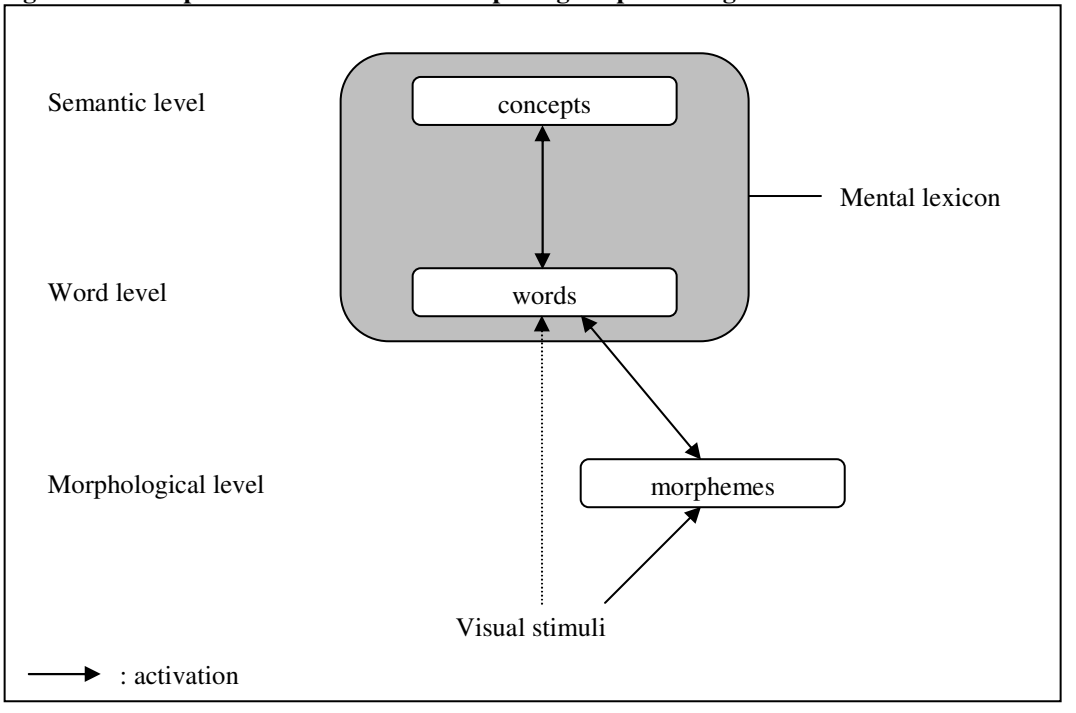
## 1. Introduction

The aim of the psycholinguistic researches that turn around morphological processing is to determine if readers are sensitive to the morphological structure of words and how this information is used during lexical access and represented in memory. Nowadays, most of the psycholinguists acknowledge the dominant role of morphological information during lexical access and the mental lexicon is envisaged as composed of concrete linguistic units of processing (orthographic, phonological, morphological and semantic units). However, scientific debates about morphological processing are mainly concentrated on where, within the architecture of the mental lexicon, morphemic units can be represented. Indeed, the precise location of such units determines their specific role in lexical access and their nature from a linguistic point of view (i.e., lexeme vs morpheme-based morphology, see Aronoff, 1994). Some studies defend the hypothesis according to which morphemes stand as access units (cf. Figure 1).

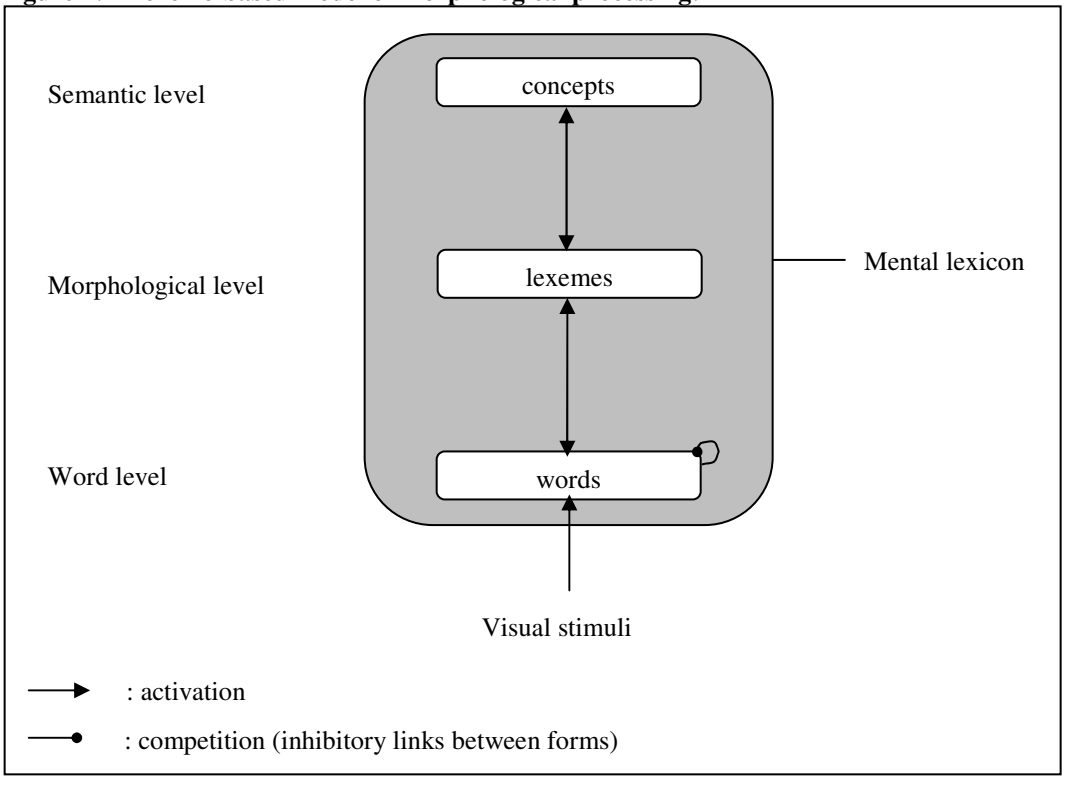
**Figure 1: A morpheme-based model of morphological processing:**




According to this view, word recognition is based on an automatic morphological parsing of the surface form of any stimulus (word or pseudo-word) that presents a letter sequence that "could be" a morpheme. In this view, derived (e.g., *baker*) and pseudo-derived words (e.g., *corner* is not a derived word, but includes *corn* and *-er* that resemble to an existing base and suffix) and even pseudo-words made

with morphemes (e.g., *bakable*) are automatically parsed into morphemes in order to access word units. The consequence of this decompositional mechanism is that all these types of words behave exactly like morphological complex words. Therefore, in this view, morphological information is represented as separate and independent morphemes (roots and affixes) that permit lexical access. This approach was baptized the sublexical hypothesis in reference to the sublexical model developed by Taft in 1994. Other authors suggest, on the contrary, that lexeme units (i.e., morphological bases which do never surface as a concrete word forms) are situated at the interface of the word level and the semantic level of processing (cf. Figure 2).

**Figure 2: A lexeme-based model of morphological processing:**




This hypothesis, derived from the supralexical model of morphological processing proposed by Giraudo & Grainger (2000), implies that lexical access is based on whole word processing. Lexical units are directly activated by the visual stimulus and morphologically complex words as well as root words are connected with their constituent morphemes, envisaged as being lexemes (i.e., abstract units) at the upper level. Then, morphologically related words are organized in morphological families thanks to facilitatory bidirectional links with their base. Several experimental studies were carried out in order to dissociate the sublexical and the supralexical approaches. Most of them used the priming paradigm that permits to examine the facilitatory or the inhibitory effect of the prior presentation of a prime (word or non word) on the recognition latency of a word target. The priming paradigm is based on the hypothesis that "the cortical representation of the prime and the target are interconnected or overlap in some way such that representation of the prime automatically activates the representation of the target word" (Forster, 1999: 6). Therefore, this experimental technique associated with a cognitive task such as lexical decision (i.e., participants are asked to determine as quickly and accurately as possible if a target stimulus is a word or not by pressing a "Yes" or "No" button) can be informative about the nature of the relationships between related words (for instance between *baker* and *bakery* or between *corner* and *corn*) and, by extension, about the structure of the mental lexicon. Reliable morphological priming effects have been obtained in several languages (Drews & Zwitserlood, 1996; Feldman, 2000; Frost *et al.*, 1998; Giraudo & Grainger, 2000; Marslen-Wilson *et al.*, 1994; San-

chez-Casas *et al.*, 2003) and using different priming techniques (masked and unmasked priming paradigms[1]). It is classically observed that a morphologically complex word facilitates the recognition of its base (e.g., *baker-bake*) relative to both unrelated (e.g., *school-bake*) and orthographic control conditions (e.g., *bacon-bake*).

## 2. Morphological effects are actually modulated by lexical factors

One of the difficulties of the study of morphology for alphabetic languages – in which the vast majority of research is conducted – is not only that morphology is correlated with semantic, orthographic and phonological factors, but also that stems and inflected or derived words exist as free word-forms, entertaining with each other different relations. These relations have been showed to be relevant to morphological processing: with the masked priming technique, Grainger *et al.* (1991) have found that orthographic similarity of the prime affects (inhibits) lexical access of morphologically complex targets, despite (or because of) the absence of any morphological relation between them. For example, the prime "mûrir" ('ripen') inhibits the target "MURAL" ('relative to walls') and this inhibition reaches 27ms for words that share their initial letters. This inhibition is accounted for in terms of "preactivation of lexical representations during the processing of the prime, that interferes with the processing of the target" (Grainger *et al.*, 1991: 380). The inhibitory effect of a prime like "blue" on the target "BLUR" (Segui & Grainger, 1990) is found, according to the same logic, because "blue" is a very powerful competitor in the recognition process of its neighbour "BLUR". The presentation of "blue" as a prime does nothing less than reinforce its competitor status, already quite important (because of its frequency), thus delaying target processing. This inhibition of O+M- (orthographically but not morphologically related primes) combined with the absence of such an effect for non word primes is also found by Drews & Zwitserlood (1995) on derivational morphology in German and Dutch. The fact that no word primes do not behave in the same manner argues in favour of the hypothesis that this competition does indeed take place at the lexical level. Interference can also be exerted by items that acquired their lexical status during the experiment: recently, Bowers *et al.* (2005) have shown that having participants learn new words (e.g., BANARA) that were neighbours of familiar words that previously had no neighbours (e.g., BANANA), made it more difficult to semantically categorize the familiar words and this interference was larger the day following initial exposure.

Following this logic, Giraudo & Grainger (2000, 2001, 2003) proposed a supra-lexical approach of morphological processing, in which abstract morphemic representations (in the sense of Aronoff, 1994) receive activation from whole-word form representations, so that word recognition enables the activation of the morphological level, and not the other way round. The key notion here is lexical competition, central for interactive activation models (e.g., Bowers *et al.*, 2005; Davis, 1999; Grainger & Jacobs, 1996; McClelland & Rumelhart, 1981). The presentation of the stimulus at the entry of the cognitive system (prime) will produce multiple activations, namely the activation of all lexical entries that share formal characteristics with the prime. These multiple representations enter a phase of competition and identification is achieved when a single word first exceeds a given threshold, thus ending the competition. The central assumption of this model is that if lexical competition processes strongly affect the identification system, they should also have an impact on morphological effects. Indeed, the manipulation of pure lexical factors like surface frequency can modify morphological effects, as Giraudo & Grainger (2000) demonstrated: high surface frequency derived primes showed significant facilitation relative to form control primes, whereas low frequency primes did not, suggesting that during prime word processing, it is the printed frequency of the prime word itself that will primarily determine morphological effects. The other component of lexical competition refers to the role of the number and the relative frequency of neighbours, i.e., words differing by a single letter (such as BANISH and VANISH; Coltheart *et al.*, 1977). Very recently, Voga & Giraudo (2007) tested the role of the lexical envi-

[1] The prime can be presented to the participant either unmasked and during more than 100 ms or masked using a forward mask consisting of hash marks (######) and for a duration under 60 ms. Using the masked priming paradigm (Forster & Davis, 1984), the prime is presented so briefly that the subject is quite unaware of its existence. Therefore, this paradigm avoids strategic responses based on the perception of the relation manipulated between the prime and the target.

ronment of the prime (in terms of competitors) and the way this lexical environment influences derivational and inflectional effects. In the study, they compared inflectional and derivational priming for large and small pseudo-family size verbs within the masked lexical decision procedure, a task that, according to recent studies (e.g. Feldman *et al.*, 2004), is not very sensitive to semantics. The three experiments reported were based on the central assumption of the supra-lexical approach, i.e. that abstract morphemic representations become active only after they have been contacted by lexical representations. The authors provided evidence in favour of two factors that affect word identification and therefore influence morphological effects: the first one was the pseudo-family size of a prime-target pair, i.e., the number of competitors a prime can activate in the orthographic-lexical level. By competitors we meant the lexical items that, by virtue of their orthographic similarity with the prime (and in the absence of any morphological relationship with it), will interfere with the processing of the target. Voga and Giraudo documented a difference in derivational priming between large and small pseudo-family size verbs: when the couple of prime-target came from a large pseudo-family, no derivational priming was observed, whereas when the prime had no competitor in the lexical level ("morphological hermit"), it induced robust morphological priming. The second factor found to affect inflectional but not derivational priming was the frequency of the target. When lower-frequency inflected targets were used instead of base forms, inflectional priming effects were (numerically) of lesser amplitude for verbs of small pseudo-families, than for verbs of large ones. Assuming that inflected verb forms in general and low frequency ones in particular are stored in the mental lexicon is a natural position in a supra-lexical morphology (and in a Word and Paradigm morphology in general), but it is far from being uncontroversial. In a sub-lexical account for regular inflections (Pinker, 1991; Taft, 1994), low-frequency inflections are parsed and do not have their own traces in memory. Nevertheless, the pattern of inflectional priming in exp. 3, slightly different from that observed in exp. 1, can be explained by the modification of the relative frequencies between primes and targets, and frequency is a lexical characteristic. When lexical decision is not anymore operated on the member of the inflectional paradigm that is already the most activated (by virtue of its frequency), more time is needed for the identification of the target and this permits us to examine a larger window of processing lexical units. Under these conditions, lexical interference effects can manifest themselves in a more visible way. We thus obtained evidence for reduced lexical competition via the enhanced repetition priming for inflected verb forms that had no pseudo-family. This enhanced repetition priming would not have emerged if inflected forms had no lexical representation. So, it seems that lexical competition intervenes not only in the processing of derivations, but in the processing of inflections as well, though in a way modulated by the characteristics of the inflectional paradigm. Thus, the contribution of Voga and Giraudo's study, in terms of understanding inflectional processing, was that by manipulating lexical factors (pseudo-family size and frequency of the target) they managed to modulate inflectional morphological priming in a way that hints at influences of lexical competition.

## 3. Different degrees of semantic overlap

Morphologically related words also overlap in meaning and according to different degrees. By definition, derived words are typically obtained by the adjunction of an affix to a base and unlike inflexion derivation implies a grammatical as well as a semantic change. As a consequence, the semantic relationships between the base and its derived forms vary along a continuum going from complete opacity to complete transparency. Transparent forms correspond to derived words that are clearly related to the meaning of their base as *punishment* and *punish*. On the opposite, derived words are considered as being semantically opaque when they are etymologically but not semantically related to their base as *casualty* and *casual.* Numerous studies have shown that morphological priming effects differed from mere formal or semantic overlaps; however, the issue about the impact of semantic variations in morphological priming remains crucial. Indeed, it could determine the locus of morphemic representations within the lexicon. If morphemes stand as access units, morphological priming effects should not be sensitive to the nature of the semantic relationships shared by prime-target pairs. According to this view, only the surface form counts: either the prime can be decomposed, then it produces priming or not. On the other hand, the lexeme-based morphology approach in which abstract bases are used to

organize word forms in morphological families postulates that opaque forms cannot be connected to their base. Therefore, opaque forms cannot prime their base. However, the absence or presence of facilitation effects from opaque derivations could be conditioned by the prime exposure duration. In the model, word forms are activated by the prime before their base forms. Activation spreads on all the word forms that can match the prime. At the same time, activated word representations begin to send activation to their respective base. In turn, activated bases send back activation to their related forms, strengthening their prior activation. Therefore, during the very early stages of word processing the system should be blind to the semantic relationships of morphologically related forms. However, semantic transparency gets a progressive impact, while the prime exposure duration is increased. Experimental results differ precisely according to the priming technique adopted. Within an unmasked priming paradigm, it has been shown that only transparent derived words facilitated the recognition of their base. On the contrary, semantically opaque derived words were not able to produce significant priming effects relative to control baselines (Feldman & Soltano, 1999; Marslen-Wilson *et al*., 1994; Rastle *et al.*, 2000). Using the visual masked priming technique, morphological facilitation can however be obtained for word pairs sharing semantically transparent as well as opaque relationships (Feldman *et al.*, 2004; Frost *et al.*, 1997; Longtin *et al.*, 2003; Rastle *et al.*, 2000, Rastle *et al.*, 2004, Sanchez-Casas *et al.*, 2003). Therefore, it seems that semantic relatedness does not necessarily drive morphological effects within masked priming. The study carried out by Longtin *et al.* (2003) on French has recently further manipulated a particular category of simple words called pseudo-derived words. According to these authors, a pseudo-derived word is defined as a word that can be "parsed into morphemes but is actually neither synchronically nor diachronically composed of these morphemes" (p. 316). For instance, the word *corner* is considered as a pseudo-derived because it contains *corn* and *-er* that resemble to existing morphemes in English but *corner* is neither synchronically nor diachronically derived from the base *corn*. However, these authors have shown that pseudo-derived primes were able to produce significant priming effects in comparison to unrelated controls because of their *surface morphology*. Moreover, pure orthographic overlap was manipulated in this study and it did not reveal any significant effects. The authors concluded that priming effects could be obtained whenever the prime is morphologically decomposable at its surface level and suggested that "words are decomposed automatically into morphemic units in the early stages of visual word processing, even when this morphemic decomposition seems not helpful" (Longtin & Meunier, 2005: 21). More recently, however, Giraudo (2007) reexamined this pseudo-derivation effect through four masked priming experiments. This new study was first motivated by our analysis of the materials used by Longtin and her colleagues and second, by the criticisms that could be formulated regarding the experimental design they used. A meticulous analysis of the 20 pseudo-derived words selected by Longtin and her colleagues reveals that 11 of them contain a diminutive suffix (*-ette, -on, -elle, -eau*). In our opinion, the use of evaluative suffixes – even if these words are not actually derived words – is quite problematic because, unlike the other derivational suffixes, they do not change the grammatical category of their base (i.e., the word *fillette*, 'girl-DIM' is a noun derived from another noun *fille*, 'girl'). As a consequence, words derived with a diminutive suffix maintain a very transparent semantic relationship with their base, and in this precise case, these pseudo-derived words could be perfectly accepted by the native speaker as possible derivations for the base they contain. For instance, the common meaning of the word *baguette*, which contains the pseudo-root *bague* ('ring'), is 'small stick', but a word *baguette* meaning 'small ring' could exist as well, and this meaning would not pose any problem of interpretation to speakers of French. Besides, the adjunction of evaluative suffixes is frequently used by speakers in order to form new words on line, which are not lexicalized.[2] These suffixes are therefore very productive and their predominance in the list of pseudo-derived words (11 among 20) could have induced an experimental bias. Finally, three other pseudo-derived words were actually derived words. They were not related to the manipulated targets, but shared a homographic root. For instance, Longtin and her collaborators selected words like *bougeoir* ('candlestick') which is actually derived from *bougie* ('candle') whose bound stem *boug-* is an homograph of the stem *boug-* in *bouger* ('to move'). Secondly, in the visual masked priming experiment

[2] Examples are numerous in the language of the press. Remember, e.g., the word *juppette*, formed with the name of a former French prime minister, Alain Juppé and the suffix *-ette* with the meaning 'governmental measure encouraging car purchase made by Alain Juppé'.

conducted by Longtin and her colleagues, four types of word primes were selected: derived words that were semantically transparent, words which were derived but opaque, pseudo-derived words and orthographic control words. However, instead of keeping the same target for each priming condition, the effects of each condition were compared individually relative to an unrelated control condition. Consequently, targets were not the same through the various conditions. Even if the authors matched targets and primes within numerous dimensions, this experiment cannot directly compare the relative effects of each type of prime on target processing. Giraudo (2007) selected 40 French pseudo-derived words all containing a pseudo-root and a pseudo-suffix (26 different nominal and adjectival homogenous suffixes). In all the experiments, targets were primed in four conditions: (1) a derived word condition, (2) a pseudo-derived word condition, (3) an orthographic word condition and (4) an unrelated word condition. Four experiments in which the target was the same for the pseudo-derived, derived, orthographic and unrelated conditions were constructed. In Experiments 1 and 2, derived word targets were used and the results revealed that, while pseudo-derived word primes differed from unrelated primes, only derived primes differed significantly from orthographic controls. Moreover, derived word primes produced an advantage on pseudo-derived primes and this difference was significant. Experiments 3 and 4 were carried out with root targets and the results showed that only derived primes significantly facilitate their root recognition. Pseudo-derived primes did not differ neither from orthographic nor from unrelated control primes. Finally, as previously observed, the difference between derived and pseudo-derived primes was significant, giving the advantage to derived words. The results presented by Giraudo best fit with a lexeme-based model of morphological processing in which lexemes are situated at the interface of the word and the semantic levels. According to the morpheme-based model, pseudo-derived words should produce indeed morphological priming effects in the same way that derived words do. As long as a word or pseudo-word prime can be parsed into existing morphemes, target recognition takes advantage of the pre-activation of one of its morpheme. Longtin and her collaborators observed this effect. On the other hand, Giraudo using much more controlled materials and design did not. Therefore, it seems that in particular circumstances pseudo-derived words induce particular orthographic processes that can only be explained within a supralexical architecture.

## 4. Conclusion

The psycholinguistic study of morphological processing using French materials provided evidence for the fact that morphological processing needs to be examined according to two dependent angles, one lexical and one semantic. Numerous lexical factors like surface frequency, family size, pseudo-family size, orthographic neighbourhood and semantic transparency have indeed been shown to influence and modulate morphological effects. As a consequence, morphological processing should not be envisaged as simple morphological parsing, a morphological cut-out, whose aim is to permit lexical access. Morphological processing has instead a central role in the organisation and the working of the mental lexicon. The recognition of morphologically complex words engages multiple cognitive processes that operate in parallel. Morphological priming effects result from the simultaneous activation of word forms and lexemes that interact during lexical access. These interactions are governed by a mechanism of competition between formally related forms that receive a back activation from lexemes at the upper level. The other aspect to notice concerns the importance of a meticulous control of the experimental materials, and conclusions should be made relative to the experimental paradigm used, including the exposure duration of the stimuli during experiment.

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