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Early and Late Effects of Morphological Decomposition: Brain Correlates of Family Size Effects on Complex Words and Pseudowords

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Summary

In three ERP experiments, morphology-based decomposition of words and pseudowords was explored in Spanish. Subjects were asked to perform a lexical decision task on morphologically simple (e.g. 'sun') and complex (e.g. 'allerg+ic', 'allerg+ist') word strings, while family size for both lexemes/stems (S-FS) and morphemes/suffixes (M-FS) was varied. In Experiment I, earlier results by Schreuder & Baayen (1997) were replicated: Monomorphemic High-FS targets produced faster responses than monomorphemic Low-FS targets. On the whole, mean voltage amplitudes for Low FS were higher than for High FS; the actual process takes place, however, at a late stage. In Experiment II, where lexical roots were used as primes, late Family Size effects emerged. Lexical decisions were based principally on lexicality. In Experiment III, words and pseudowords were matched for Stem Family Size and Morpheme Family Size was manipulated: morphemes were used as primes. Word and pseudoword targets which contained a high family size (HFS) morpheme require 21ms less than word and pseudoword targets which did not, showing that HFS morphemes facilitate word recognition. Our data with monomorphemic words seems to support Schreuder & Baayen's (1995) model. Results with polymorphemic words cannot be accommodated within a framework that ignores the relationship between whole word and morpheme.

Keywords: lexeme family size; morpheme family size; morphological decomposition; visual word recognition.

Exploring Morphological Decomposition

Although it is generally acknowledged that morphology has an important role to play in language comprehension and production (Anderson, 1992; Aronoff, 1994), it remains unclear what that role actually is. Some authors contend that whole-word representations are stored directly in the brain (Butterworth, 1983); others propose that only morphemic units and their combinatorial constraints are stored, without any role for whole-word representations (Taft, & Forster, 1975). More recent models accept the coexistence of interlinked whole-word and morphological representations (Caramazza, Laudanna & Romani, 1988). The problem with this contention is the way morphological structure relates to lexical structure and the way this information is conveyed by any lexical unit, whether a lexeme or a morpheme. In this sense we must consider not only the peculiarities of the different languages studied (Longtin & Meunier, 2005), but also the fact that there are several different morphological

processes at work, each with different theoretical implications. Both of these factors impede direct extrapolation of results. Some authors postulate that there are individual links between words and morphemes within a specific morphological family framework (Bybee, 1985). However, such morphological families are defined by structural word properties such as sharing a common stem or pertaining to a common semantic field. It has long been debated whether or not lexical units can be defined independently of the meaning conveyed. Access to lexical composition might be prelexical, implying that a particular word is decomposed into smaller lexical units, (Fabre, Meunier & Hoen, 2007; Meunier & Longtin, 2007), or postlexical, meaning that a whole word should be active before its morphemic units can be accessed (Giraud & Grainger, 2001, 2003). Whilst it is somewhat unclear whether morphemes and lexemes can be treated as analogous lexical units, there is linguistic evidence that concept instantiation for a particular word is always made by concatenating a root or stem with a morpheme, at least in every compositional language and concatenative grammar.

A preliminary experiment was conducted to replicate a Family Size effect originally reported by Schreuder and Baayen (1997, 3rd Experiment) in Spanish, with behavioral and ERP responses recorded simultaneously in order to study the temporal course of the effects. In the original paper, Family Size was defined as the number of lexical entries that can be constructed from a lexical stem by concatenating legal morphemes, and only behavioral data was used. Two additional experiments were then conducted, in which subjects were asked to perform a lexical decision task on morphologically complex words and pseudowords, manipulating family size of both lexemes (S-FS) and morphemes (M-FS). Our hypothesis was that if subjects are sensitive to Family Size variations in complex words, they must have broken a lexical candidate down into its lexical sub-units. A FS effect in either direction, would be evidence in favor of the morphological decomposition models, as opposed to full-listing models (De Jong, Schreuder & Baayen, 2000). In addition, if this parsing followed by concatenation actually occurs, the EEG will reveal the temporal sequence of processes involved, providing some evidence for pre- or postlexical models.

General Methodology

Using SuperLab 4.0 software (Cedrus Corporation, 2006) in every experiment, right-handed native Spanish readers with normal or corrected-to-normal vision are serially presented in sequence with a fixation point (0.5s), blank screen (0.5s), postmasked word-string prime (70ms) (experiments II and III only), and postmasked word or pseudoword target (1.5s). Readers were then asked to make a lexical decision while brain activity was recorded using a 64-electrode cap and BrainVision Recording System. Response times (RTs), and Evoked-Related Potentials (ERP) were taken as dependent measures. Error rates (ER) were also taken as a control for efficiency. RTs were measured from the target onset until subjects made a response.

Cross-trial average ERPs elicited by the stimuli were computed for each participant, and then averaged across subjects for every combination of Lexical Status (LS) and Family Size (FS), according to the design. The average amplitude in the 300ms pre-probe interval (when no stimulus is being presented before a new trial) was taken as the baseline. The time epoch extended from 300ms prior to probe onset until 1000ms into the response interval. ERPs elicited by the probes were computed for each of 6 latency peaks (70, 100, 170, 200, 300, 400) by averaging amplitudes over the peak latency interval (-25, +25ms), once DC and ocular artifacts were removed. Since error rate was very low, all trials were used. Impedances were kept below 2k Ω .

Repeated-measures by-subject (F1) and by-item (F2) ANOVAs for behavioral and ERP measures were performed separately. ERP measures in the relevant variables were obtained for each time interval and each major brain area by averaging amplitudes of all electrodes in the area. Only RTs and ERPs of correct responses less than 2.5 standard deviations from the average were used.

Experiment I: Monomorphemic Words

In this first experiment, an original design by Schreuder and Baayen (1997, 3rd Experiment) is replicated. Thus a 2 (Lexical Status: Word (W) vs. Pseudoword (PW)) \times 2 (Family Size (FS): High vs. Low) incomplete factorial design is used, where Pseudowords are not distributed according to Family Size. Neighborhood Density (ND), Syllable Length (SL) and Letter-string Length (LL) were also controlled. Table 1 shows the descriptive statistics for the relevant variables.

Table 1: Descriptive statistics for Experiment I

Word	FS	F	ND	SL	LL
HFS	7.4	13	1.8	2.7	6.5
	(.9)	(5.6)	(1.2)	(.7)	(1.1)
LFS	1.7	13	1.8	2.6	6.5
	(1.2)	(4.9)	(1.4)	(.6)	(1.1)

Frequency per million words. Standard Deviation in brackets

A set of 68 stimuli, 34 monomorphemic words and 34 pseudowords, is used in this experiment. All words were selected from LEXESP (Sebastián, Cuetos, Martí & Carreiras, 2000). Following Schreuder and Baayen

(1997), all pseudowords were created by changing one letter of an existing word, the result conforming to the phonotactic and orthotactic constraints of Spanish.

Twenty-two right-handed native Spanish readers, (18 women, 4 men of average age 19.8 years) participated voluntarily. One subject was excluded because of her error rate (> 15%). Overall error rate was below 10% for each accepted subject. Non-responses and errors were replaced in each cell by the calculated cross-average for their corresponding conditions.

Results and Discussion

RTs. A Family Size (FS) effect reaches significance in both ANOVAs, for subjects ($F(1,21)=1251.30$, $MSe=6312.66$, $p<.01$ (High FS: 585ms; Low FS: 613ms) and for items ($F(2,16)=5.409$, $MSe=1070.511$, $p<.05$). A Lexical Status (LS) main effect also reaches significance (Word (W): 599ms; Pseudoword (PW): 729ms) in both ANOVAs, for items ($F(2,133)=228.75$, $MSe=2305.33$, $p<.001$) and for subjects ($F(1,21)=85.07$, $MSe=4385.90$, $p<.001$).

ERPs. An early Lexical Status effect becomes significant in the 70ms after-stimulus-onset window, a difference that emerges between Words (-2.56) and Pseudowords (-1.47), ($F(1,10)=12.416$, $MSe=1.054$, $p<.01$). Lexical Status effects are associated with differences between Words and Pseudowords involving frontal ($p<.01$) occipital ($p<.05$) and parietal ($p<.05$) sites (Bonferroni pair comparisons: $F(1,10)=2.579$, $MSe=3.007$). A significant Hemisphere \times Lexical Status interaction is observed in the 200ms after-stimulus-onset window ($F(1,10)=23.846$, $MSe=2.429$, $p<.001$; for Left Hemisphere, Word: 0.511; Pseudowords: 1.424; for Right Hemisphere, Word: 1.467; Pseudoword: 0.085). In the ANOVA conducted in the 300ms peak interval on mean voltages, a significant Lexical Status main effect emerges (Word: 1.094; Pseudoword: 2.167; $F(1,10)=5.886$, $MSe=2.151$, $p<.05$). ANOVAs conducted in the 300ms and 400ms peak intervals on mean voltage amplitudes show significant main Family Size effects for both LH and RH (300ms: $F(1,10)=7.711$, $MSe=8.558$, $p<.05$; 400ms: $F(1,10)=7.618$, $MSe=3.990$, $p<.05$). These results are shown in Table 2.

Table 2: Mean amplitudes for Family Size

Interval	Left Hemisphere		Right Hemisphere	
	HFS	LFS	HFS	LFS
300ms	1.24	2.40	0.95	0.34
	(.21)	(.26)	(.33)	(.46)
400ms	1.14	1.86	3.81	2.86
	(.19)	(.28)	(.32)	(.28)

Means in μV . Standard Deviations in brackets.

HFS: High Family Size; LFS: Low Family Size.

It is rather difficult to attribute these ERP to an underlying component evaluating a word string according to its morphological composition. In fact, we can clearly see from these results that amplitudes are different for the

two Family Size conditions at a late stage of processing. This difference is fully congruent with Schreuder and Baayen's (1995, 1997) predictions. Their model suggests that FS facilitation is due to the propagation of semantic activation among target word family members. Proposing that the Family Size effect is driven by semantic evaluation of word strings after lexical access is therefore also totally in line with their model.

Experiment II: Stem priming

In this second experiment, priming effects of word stems on word recognition are explored. A 2 (Lexical Status: Word vs. Pseudoword) \times 2 (Stem Family Size (S-FS): High vs. Low) factorial design was used. Morpheme Family Size (M-FS), Frequency (F), Neighborhood Density (ND), Syllable Length (SL) and Letter-string Length (LL) were also controlled. Table 3 shows the descriptive statistics of the variables controlled.

Table 3: Descriptive statistics for Experiment II

	S-FS	M-FS	F	ND	LL
HFS	8.85 (1.8)	1308 (1091)	2.3 (1.86)	1.5 (.88)	7.8 (1.1)
LFS	2.35 (.9)	1572 (1026)	2.3 (2.4)	1.05 (0.60)	8.0 (1.07)

Frequency per million words. Standard Deviation in brackets

A set of 72 low-frequency word patterns, 18 words and 18 pseudowords per Family Size condition, were used. Each word is selected from LEXESP (Sebastián, Cuetos, Martí & Carreiras, 2000), and comprises a legal combination of root and suffix (e.g. allerg-ic). Each pseudoword is a non-interpretable combination of a legal root and a legal suffix, such as allerg-ible. Every stimulus in this set was randomly presented twice. A postmasked prime, consisting of the stem of the target word or pseudoword, was presented for 70ms. The prime is masked for 30ms.

Thirteen right-handed native Spanish readers, (10 women, 3 men of average age 23.2 years) participated voluntarily. Two subjects were excluded because of their error rate ($> 10\%$). Overall error rate was below 10% for every accepted subject. Non-responses and errors were replaced in each cell by the calculated cross-average for their corresponding conditions.

Results and Discussion

RTs. Main effects of Lexical Status emerge in the ANOVAs conducted for subjects ($F(1,19)= 47.65$, $MSe=3729.73$, $p<.001$ (W: 655ms vs PW: 749ms)) and for items ($F(2,1,35)=85.95$, $MSe= 3177.71$, $p<.001$ (W: 656ms vs PW: 743ms)). A main Family Size (FS) effect was found to be significant in the ANOVAs for subjects ($F(1,19)=13.1$, $MSe=523.88$, $p<.002$; High FS: 711ms vs. Low FS: 693ms), but marginally non-significant in the ANOVAs for items ($F(2,1,35)= 3.41$, $MSe=2995.03$, $p<.07$ High FS: 708ms vs. Low FS: 691ms). The Lexical Status \times Family Size interaction is significant ($F(1,19)=9.81$, $MSe=3228.7$, $p<.005$), ($F(2,1,35)=11.82$, $MSe= 11056.67$, $p<.005$). This data shows high Family

Size inhibits the lexical decision process, contrary to Schreuder & Baayen's (1997) predictions.

ERPs. ANOVAs conducted on mean voltage amplitudes in the 70, 100, 200, 300 and 400ms peak intervals show significant differences according to Lexical Status, for 70ms after stimulus onset $F(1,10)=14.454$, $MSe=3.691$, $p<.005$, for 100ms after stimulus onset, $F(1,10)=11.191$, $MSe=4.327$, $p<.01$; for 200ms, $F(1,10)=5.064$, $MSe=8.647$, $p<.05$, for 300ms $F(1,10)=18.079$, $MSe=5.204$, $p<.005$, and for 400ms $F(1,10)=19.763$, $MSe=8.978$, $p<.001$. Mean voltage amplitudes for each window are displayed in Table 4. These results replicate the main Lexical Status effect observed from behavioral measures.

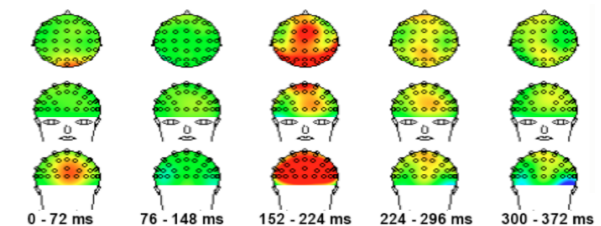


Figure 1: Low Stem-Family-Size Effects for Words

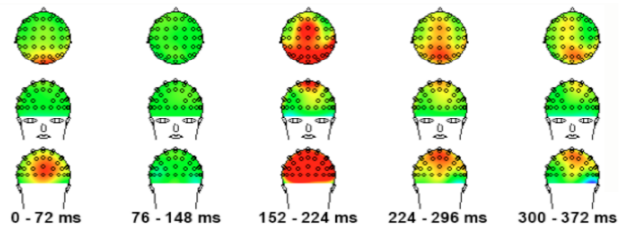


Figure 2: High Stem-Family-Size Effects for Words

Table 4: Mean amplitudes for Lexical Status

Interval	Word	Pseudoword
70	-1.805 (.1164)	-1.026 (.1085)
100	1.181 (.1505)	1.923 (.1654)
200	4.901 (.2134)	5.607 (.2090)
300	.888 (.1840)	1.922 (.1455)
400	2.74 (.1878)	4.134 (.1666)

Means in μV . Standard Deviations in brackets

The first sign of a main Family Size effect is observed 200ms after stimulus onset ($F(1,10)=14.031$, $MSe=.544$, $p<.005$) with differences in mean amplitudes between High and Low Family Size much larger for the Right than for the Left Hemisphere, and in opposite directions. Table 5 shows these results. The magnitude of this effect varies across brain areas ($F(1,10)=41.549$, $MSe=9.480$, $p<.001$). Two other Family Size effects emerge in interaction with Lexical Status, 100ms ($F(1,10)=4.517$, $MSe=2.053$, $p<.05$) and 300ms after stimulus onset ($F(1,10)=6.376$, $MSe= 5.501$, $p<.05$). The results are shown in Table 6. Brain activity maps in Figures 1 and 2 show different effects for Low and High Stem Family Size Words at late processing stages.

The behavioral results reveal an inverse FS effect, a lower FS leading to shorter response times. As Table 3 shows, in Spanish the number of derivative morphemes

that can be paired with a given lexeme is very low. Once the prime is presented, the system pre-activates morphemes that can be concatenated with this lexeme (Longtin and Meunier, 2005), and they compete with one another for eventual selection.

Table 5: Mean amplitudes for Family Size

Interval	Left Hemisphere		Right Hemisphere	
	HFS	LFS	HFS	LFS
200	4.859 (.168)	4.814 (.194)	5.399 (.233)	5.943 (.272)

Means in μV . Standard Deviations in brackets

Table 6: Mean amplitudes for the Lexical Status \times Family Size interaction

Interval	Word		Pseudoword	
	HFS	LFS	HFS	LFS
100	1.288 (.161)	1.074 (.150)	1.705 (.180)	2.141 (.168)
300	1.020 (.180)	.757 (.204)	1.422 (.170)	2.422 (.148)

Means in μV . Standard Deviations in brackets

As for the EEG results, two important caveats apply. Firstly, the amplitude measures are taken on the scalp. In the absence of any particular model of source analysis, it is difficult to determine how ERP measures translate into actual processing mechanisms. What we learn from these effects, however, is that the amplitudes differ for words and pseudowords made up of the same stems and affixes. Manipulating Family Size of stem primes has a minor late effect on lexical decisions in this experiment, secondary to Lexicality. Contrary to a morphological decomposition account, Lexicality plays a major role in both behavioral and brain response measures. Secondly, mean amplitude peaks are measured for each interval separately by averaging amplitudes over the peak latency interval (-25, +25ms) after stimulus onset. Before stimulus onset, the stem of the to-be-presented complex word string is presented as a prime for 70ms, followed by 30ms with a marker. 100ms should therefore be added to each latency interval, being the time taken to process the stem. The stem might be a reasonable predictor of lexicality, obscuring the role of morphological decomposition.

Experiment III: Morpheme Priming

In this third experiment, legal morphemes were used as primes for words and pseudowords - in this case non-words made by combining a root and suffix with incompatible grammatical categories. A 2 (Lexical Status: Word vs. Pseudoword) \times 2 (Morpheme Family Size (M-FS): High vs. Low) factorial design was used. Frequency (F), Neighborhood Density (ND), Syllable Length (SL) and Letter-string Length (LL) were controlled. A new variable was controlled in this experiment: Stem Family Size (S-FS), the number of stems a particular morpheme could be paired with. Table 7 shows the descriptive statistics of the variables controlled.

A set of 100 stimuli (50 words and 50 pseudowords)

was used, words again being selected from the LEXESP corpus. Each stimulus in this set was randomly presented twice. The stimuli were constructed in the same way as in the second experiment.

Table 7: Descriptive statistics for Experiment III

Word	F	S-FS	M-FS	ND	LL
HFS	6.2 (4.4)	9.32 (1.62)	1775 (811.9)	1.84 (.9)	7.88 (1.0)
LFS	5.8 (4.9)	9.36 (1.22)	104 (74.9)	1.68 (0.7)	7.72 (1.2)

Means in μV . Standard Deviations in brackets

Pseudo Word	F	S-FS	M-FS	ND	LL
HFS	N/A	9.32 (1.62)	1775 (811.9)	N/A	8.20 (.9)
LFS	N/A	9.36 (1.22)	104 (74.9)	N/A	8.16 (1.2)

Means in μV . Standard Deviations in brackets

Eighteen right-handed native Spanish readers voluntarily took part (15 women, 3 men of average age 20.7 years). No subject had more than a 10% error rate. Non-responses and errors were replaced in each cell as above.

Results and Discussion

RTs. Significant main effects for Lexical Status ($F(1,17)=123.202$, $MSe=1636.759$, $p<.001$; $F(1,49)=230.752$, $MSe=2534.977$, $p<.005$) and Morpheme-FS ($F(1,17)=22.581$, $MSe=242.194$, $p<.001$; $F(1,49)=9.227$, $MSe=2292.506$, $p<.005$) are observed in the ANOVAs conducted on RT; the interaction, however, does not reach significance. On average, Words took 697ms to process, Pseudowords 805ms. Word and Pseudoword targets which contain a High Family Size (FS) morpheme require 21ms less than Word and Pseudoword targets containing a Low FS morpheme (740ms vs 761ms). High FS morphemes therefore have a facilitatory effect on word recognition. This finding supports Schreuder and Baayen's (1997) predictions.

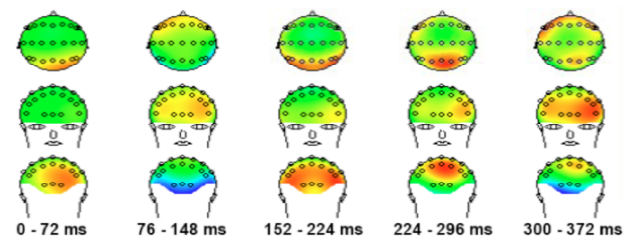


Figure 3: Low Morpheme-Family-Size Effects for Words

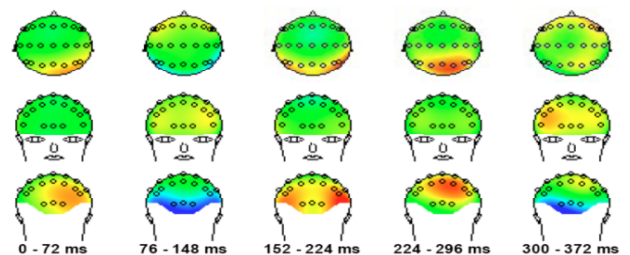


Figure 3: High Morpheme-Family-Size Effects for Words

Table 8: Mean amplitudes for Lexical Status

Interval	Left Hemisphere		Right Hemisphere	
	W	PW	W	PW
70	-.42 (.06)	-.34 (.05)	-2.24 (.14)	-1.74 (.13)
300	2.35 (.12)	2.21 (.13)	-.51 (.22)	.09 (.25)

Means in μV . Standard Deviations in brackets

ERPs. ANOVAs conducted in the 70ms peak interval on mean voltage amplitudes show a significant main effect for Lexical Status ($F(1,17)=6.64$, $MSe=0.95$, $p<.05$). This Lexical Status effect also emerges in the 300ms window ($F(1,17)=3.405$, $MSe=3.416$, $p<.05$). Interestingly, the actual effect does not change direction between these windows. Planned pair comparisons show significant differences between the two levels of the Lexical Status conditions, with mean voltage amplitudes significantly larger for LH than for RH at both intervals (70, 300), when whole-word models are accessed and when incoming word cues are to be integrated. The relevant results are shown in Table 8. As for Morpheme Family Size, clearly significant effects emerge at 70ms ($F(1,17)=6.64$, $MSe=.95$, $p<.001$) and at 100ms ($F(1,17)=5.64$, $MSe=.984$, $p<.001$). At this early stage, a double Lexical Status \times Morpheme-FS interaction reaches significance ($F(1,17)= 3.387$, $MSe=2.777$, $p<.005$, with mean voltage amplitudes for words ($2.29\mu\text{V}$) larger than for pseudowords ($1.25\mu\text{V}$). Brain activity maps for both Low and High Morpheme-Family Size for Words are displayed in Figures 3 and 4. No other effects are significant. In order to correctly interpret these effects, as in the second experiment, the role of the prime must be taken into account: morphemes are available 70 ms before the entire word pattern. Nonetheless, an early Lexical Status effect is found under these conditions. As expected, in this third experiment there is no sign of an inhibitory FS effect from the behavioral analysis.

General Discussion

In this study we first replicated Family Size effects obtained by Schreuder and Baayen (1997). Behavioral results show that low FS words are recognized later than high FS words. The combined behavioral and EEG data show that larger FS facilitates access to the word itself (Carlisle & Katz, 2006). In addition, the EEG results show late semantic effects associated with the FS variable, as observed by Lehtonen, Cunillera, Rodríguez-Fornells, Hultén, Tuomainen & Laine (2007). High Family Size produced facilitatory effects on monomorphemic words at the stage where incoming cues are integrated into whole-word representations. The role of the morphological structure of words and pseudowords was then explored in two additional masked priming experiments. In the second experiment, the effect of priming with actual roots is compared for words and pseudowords. In the third experiment, we turned to word recognition primed by existing morphemes. Behavioral

data from the second experiment does not support Schreuder and Baayen's predictions: a High Family Size root has an inhibitory role in lexical decision. This inverse FS effect has been noted previously, for example by Taft et al. (2004) with his inflectional morphology. His results are explained in similar terms to those of Meunier & Segui (1999), who propose that suffixed words belonging to the same morphological family are organized around a shared lexical entry, and must therefore compete with one another for activation. In other words a morphological process occurs, where competition is based on the frequency of concatenation of morphemes with their lexemes. This competitive process did not occur in the third experiment, although in theory this solution could also apply here. The reason for lexical competition being observed in the second experiment but not in the third lies in the linguistic properties of the prime and of the different morphological elements in play. Whilst in the second experiment the prime was the lexeme of the target stimulus, in the third it was the derivative morpheme. According to Meunier & Longtin (2007), the use of morphological primes can pre-activate associated entries, and so lexemes and morphemes may prime for different information, depending on their linguistic properties. In tables 3 and 7 we can see how morpheme and lexeme FS varies greatly. In the case of lexemes, the mean number of candidates does not rise above ten, while the number of lexemes that can be paired with a morpheme is over a thousand. Thus if our prime is useful, and pre-activates a limited set of candidates (as in the second experiment) we can defend the idea that a lexical competition process is under way. If, on the other hand, our prime preactivates hundreds or even thousands of candidates (as in the experiment three) it provides negligible information of use to us, and there is no possibility of competitive processing taking place. Lexical competition is viable where the number of candidates pre-activated is small enough to make this process an efficient task, which only occurs if the lexeme prime is used. As for the Lexical Status variable, in experiment two and three we can see robust, significant lexical status effects - early (also observed by Hauk, Pulvermüller, Ford, Marslen-Wilson, & Davis, 2009, and Segalowitz & Zheng, 2009) as well as late. In our opinion, this late effect marks the lexical decision itself. One decisive factor on the results of this experiment was the use of words and pseudowords in which the concatenation of lexemes and morphemes formed plausible words which in some cases actually existed

(words) and in others did not (pseudowords). The system must therefore make a lexical decision not based on FS, but rather on the compatibility of the morphemes expressed. This situation forces an exhaustive analysis of morpheme compatibility, which is expressed in the frequency of concatenation of the stimuli. If the concatenation has a frequency higher than 0, the stimulus is a real word. Family Size effects are dependent on lexicality and frequency. In the third experiment, the apparent early Family Size effect might be an artifact of masked priming (Longtin & Meunier, 2007), but there is evidence to suggest that morphological decomposition does concur with LH lexical activation as we would

expect. Morphologically complex words can be directly accessed only when their whole-word representations are activated and their morphemes are too.

Morpheme Family Size plays a major role in the word recognition process, but morpheme availability depends on whole-word activation, as revealed in the second and third experiments by the role of Lexical Status and its interaction with Morpheme Family Size. The facilitative and inhibitory effects obtained can be attributed to intralexical mechanisms. In contrast with the stem, a morpheme cannot generally make a truly independent contribution to the lexical status of a word candidate. In our opinion the lexeme clearly guides word recognition (Lehtonen et al., 2007).

The results obtained in the three experiments sit easily within a lexical model that conceives lexemes as partially independent lexical units, but their computation depends on the Lexical Status of the whole-word pattern. It is a fact that morphemes are not learnt independently of the lexical entries they form part of.

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