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SUFFIX PERCEPTUAL SALIENCE IN MORPHOLOGICAL MASKED PRIMING

HÉLÈNE GIRAUDO SERENA DAL MASO

ABSTRACT: A masked priming experiment was conducted in order to determine whether suffixes and morphological schemas play a role in the access and processing of Italian complex words like bases do and, more precisely, whether (i) the suffix salience and (ii) the consistency of the suffix series affect processing. To this end, three suffixes with different perceptual characteristics, i.e., *-tore*, *-ico* and *-etto*, and whose series present a different degree of functional consistency, were manipulated. The results indicate very clear base priming effects for *-tore* and *-ico* targets (e.g., *nostalgia-nostalgico*; *pescare-pescatore*) but no effect for *-etto* targets. On the other hand, while the suffix priming condition did not reveal any effect for *-tore* and *-ico* (e.g., *sinfonico-nostalgico*; *traditore-pescatore*) compared to the unrelated condition, *-etto* series yielded the longest reaction times (RTs). The distributional properties, together with the non-prototypical semantic and functional characteristics of *-etto*, seem therefore to affect also the relation between the base and the suffixed word. We conclude that different nature of morphological entities might imply different priming effects and that suffixes might need more activation than bases to emerge.

KEYWORDS: masked priming, suffix salience, functional consistency, morphological processing, Italian suffixes.

1. INTRODUCTION

In usage-based approaches to language representation and processing, mainly Bybee's Network Model (e.g., Bybee 1985, 1995) and Booij's Constructional Morphology (e.g., Booij 2010), morphology is generally conceived as organizing the lexicon according to two main dimensions: (i) morphological families, i.e., words connected because they share the same root: *kind/ kindness/ kindly/ unkind/ kind-hearted*, etc. and (ii) morphological series, i.e., words connected because they share the same affix *kindness/ happiness/ sadness/ abruptness*, etc. This view has been mainly confirmed by psycholinguistic research, which demonstrated with experimental data generally obtained

through the use of the masked priming experimental technique (Forster & Davis 1984), that words in the mental lexicon are stored according to both formal and semantic similarities, thus following morphological principles. The use of masked priming protocols, which focus on the effect of the (mostly visual) presentation of a stimulus word (the ‘prime’) on the recognition of a target word, has shown that the recognition of the target word is faster when preceded by a morphologically related prime (e.g., *kindness* - *kind*), compared to the cases where it is preceded by an unrelated word (e.g., *drawing* - *kind*) or by a word which is only orthographically similar (e.g., *finding* - *kind*). According to Forster, these results show that “the cortical representations of the prime and the target are interconnected or overlap in some way such that the representation of the prime automatically activates the representation of the target word” (Forster 1999: 6).

Morphological families and series, however, have not been equally investigated so far. The relationship between morphologically complex words and their roots (e.g., Grainger et al. 1991; Drews & Zwitserlood 1995; Giraudo & Grainger 2000; Rastle et al. 2000; Rastle et al. 2004; Diependaele et al. 2005; McCormick et al. 2008; Kazanina 2011; Orfanidou et al. 2011) or between members of the same morphological family (e.g., *deform-conform*, Pastizzo & Feldman 2004; see also Giraudo & Grainger 2001; Giraudo & Voga 2013) has been extensively explored and yielded clear-cut results; strong facilitation for the base condition is in fact one of the most established effects in visual word identification (e.g., Grainger et al. 1991). On the contrary, the connection between words sharing the same suffix or, in constructional terms, belonging to the same morphological schema, such as *kindness/happiness/sadness*, has been investigated only in a limited number of studies; moreover, the results obtained so far do not allow a consistent and univocal interpretation.

Among these studies, Marslen-Wilson et al. (1996) considered affix priming in relation to productivity. More precisely, they investigated whether affixed words with productive and non-productive suffixes (*-ation*, *-able*, *-ness*, vs. *-al*, *-ate*) and prefixes (*re-*, *pre-*, *dis-*, vs. *in-*, *en-*, *mis-*) prime words with the same affix; they thus opposed a productive condition, i.e., *darkness/toughness* and *rearrange/rethink*, to a non-productive one, i.e., *adjustment/government* and *enslave/encircle*. A cross-modal priming task was used: subjects first heard an auditory prime word, then replaced by a visual target (a word or a non-word), on which they had to perform a lexical decision task. In this experiment, they found a significant priming effect for words sharing the same productive affix, either prefixes or suffixes (i.e., respectively *darkness/toughness* and *rearrange/rethink*), which paralleled the base priming effects. In other words, the overall priming effects for derived-derived pairs were as

strong as those for derived/base pairs.¹ Priming for unproductive suffixes and prefixes, while still significant, was somewhat weaker. In order to verify that this effect was genuinely morphological, Marslen-Wilson and colleagues conducted a second experiment opposing truly affixed words to pseudo-affixed words, i.e., words that show an orthographic overlap though sharing a non-morphological ending or word onset only (i.e., *darkness-harness*, *adjustment-garment*, *rearrange-recent*, *misfire-mistress*, *vintage-vindicate*, *puritan-charlatan*). Their results showed that the pseudo-affix conditions did not yield any significant facilitation; even more, that the word initial overlap generates a significant interference effect, while only a minor interference effect emerges in the final overlapping condition.

More recently, Giraudo & Grainger (2003) conducted a series of masked priming experiments in which they controlled for the affix effect on the processing of both prefixed and suffixed words in French. They compared affixed word pairs sharing either the same prefix (e.g., *enjeu-envol*, 'stake'-'flight') or the same suffix (e.g., *fumet-muret* 'scent'-'wall') to pseudo-affixed pairs (in which the primes comprised a pseudo-affix, e.g., *ennui-envol* 'boredom'-'flight'; *béret-muret* 'beret'-'wall') and to unrelated controls (e.g., *biche-envol* 'doe'-'flight'; *crabe-muret* 'crab'-'wall'). The results of Experiment 1 revealed that only prefixed primes facilitated target recognition relative to both the orthographic and the unrelated conditions. Other experiments were carried out in order to clarify the asymmetry between the results obtained with prefixes and suffixes; however, the absence of suffix priming effects could not be attributed to semantic factors (Experiment 2), nor to the surface frequency of the affixes (Experiment 3), as emerged in the findings of Marslen-Wilson et al. Interestingly, in order to maximize the suffix salience within the critical words, in Experiment 4 the authors manipulated formal factors and selected suffixed words in which the morpheme boundary coincided with the syllable boundary (e.g., *pliage* 'folding' is composed of the stem *pli-* and the suffix *-age* and can be syllabified as *pli/age*). Nevertheless, even when the suffix boundaries were aligned with the syllable structure (e.g., *rouage-pliage* 'cog'-'folding') no significant suffix priming effects could be observed compared to pseudo-suffixed word primes (e.g., *stage-pliage* 'internship'-'folding'). All in all, Giraudo and Grainger's data firstly indicate that no suffix priming effects emerge in masked priming experiments with French materials and, secondly, suggest an asymmetrical morphological processing of prefixed and suffixed words which cannot be accounted for with neither exclusively orthographic nor semantic explanations.

¹ It should be noted, however, that the derived/base effect has not been verified on the same materials used for the derived-derived condition in a within-comparison design, but with other prime-target pairs, i.e., *absurdity-absurd* (i.e. *darkness* primed *toughness*, but not *dark*).

Starting from what has been considered the potential limitations of the Giraudo and Grainger study, Duñabeitia et al. (2008) tested suffix priming effects in Spanish. Giraudo and Grainger's limitations would be due to the fact that their orthographic primes corresponded to monomorphemic words with a pseudo-affix (e.g., *ennui*; *béret*), while numerous priming studies demonstrated strong decomposition effects not only for morphologically related prime-target pairs (e.g., for hunter-hunt), but also for "surface morphology" - orthographically but not morphologically - related pairs (e.g., *corner-corn*, see Rastle & Davis 2008 for a review of the literature on morpho-orthographic segmentation and the so-called 'corner effect'). In order to avoid this difficulty, the authors looked for a facilitation effect on the recognition of suffixed words in Spanish by means of a series of masked priming experiments with different degrees of prime segmentation: (1) *dad* - *IGUALDAD* 'ty' - 'equality' (Experiment 1); (2) %%%*dad* - *IGUALDAD* '%%%ty' - 'equality' (Experiment 2); (3) *brevedad* - *IGUALDAD* 'brevity' - 'equality' (Experiment 3). The results revealed significant priming effects with respect to the unrelated control (i.e., *aje* - *igualdad*, %%%*aje* - *igualdad*, *plumaje*-*igualdad*) in all the conditions (independently of the degree of segmentation of the prime) and a clear dissociation between orthographic and morphological priming (e.g., *brevedad* primes *igualdad*, but *volumen* does not prime *certamen* 'volume' - 'contest'). In line with Marslen-Wilson et al. 1996, these results have been considered strong evidence in favor of an early pre-lexical morphological decomposition (e.g., Duñabeitia et al. 2008; Rastle et al. 2004) of all forms that can be potentially split into two 'surface morphemes' (see for details Rastle & Davis 2008) and, most importantly, they attributed to both stems and affixes an equal status of access units during the early stages of word recognition.

In the same line of reasoning, Crepaldi et al. 2016 reinvestigated the affix priming effects using non-words in order to minimize any possible lexical competition between primes and targets (e.g., Davis & Lupker 2006; Segui & Grainger 1990) that may have obscured the role of the suffix in previous investigation (e.g., Giraudo & Grainger 2003). Specifically, they used non-words like *sheeter*² (composed by an existing stem *sheet* and an existing suffix -er) as primes for target words with the same suffix, such as *teacher*. 'Morphological' effects were compared to those obtained in a condition where the critical suffix was substituted by another one (e.g., *sheetal* - *teacher*) or by an unrelated non-morphological ending (*sheetub* - *teacher*). Moreover, simple real words with the same orthographic characteristics were used in the same conditions (e.g., *pollel* - *barrell* vs. *pollic* - *barrell* vs. *pollut* - *barrell*) in order to

² It must be highlighted, however, that a word like *sheeter* is an attested form found on the web and thus can be assimilated to a possible word. As a consequence, it does not seem to have the same status as a genuine non-word, which is a non-analysable sequence.

differentiate, according to the authors, ‘orthographic’ from ‘morphological’ effects. The results revealed significant priming effects for the complex pairs, e.g., *sheeter* - *teacher* (respectively, +23 ms relative to the suffixed control condition, e.g., *sheetal* - *teacher* and +35 ms to the unrelated condition *sheetub* - *teacher*), but not for the simple word pairs like *pollel* - *barrel*.

So far, suffix priming emerged in a quite inconsistent way, with different (and somehow incomparable) materials and experimental paradigms: facilitation effects were found in masked priming experiments with non-words in English (Crepaldi et al. 2016) and with real words in Spanish (Duñabeitia et al. 2008), but no effect was obtained with real words in French (Giraudo & Grainger 2003). Priming effects for real words were found in English only with a cross-modal priming technique (Marslen-Wilson et al. 1996). Before drawing any conclusions, some aspects need to be discussed and considered with caution. Firstly, results on non-word processing cannot be simply extended to the interpretation of word access. More precisely, in relation to the segmentation conditions used by Duñabeitia et al. 2008, we might wonder whether the Spanish form *dad* can be considered as a suffix when it occurs in isolation and not as a word ending. Even if we acknowledge that a suffix has a mental representation, in language use it is still a bound morpheme, which needs to be combined with a stem in order to exist and have a functional status. As claimed by Booij, “bound morphemes do not have a meaning of their own” (Booij 2015: 5). As a consequence, it is the constructional schema as a whole that imposes its interpretation. Accordingly, a facilitation yielded by *dad*, or, even worse, in a condition where *dad* occurs at the end of a non-linguistic string, e.g., %%%*dad*, does not *ipso facto* reflect morphological effects, but rather very early formal effects. The same criticism can be addressed to Crepaldi et al.’s materials: their interpretations deal with the processes involved in word recognition, while their data come from non-word processing. We seem to be faced here with some methodological bias, because if the authors make a direct link between the processing of complex non-words and the processing of complex words it is mainly because they test a decompositional hypothesis starting from the assumption of the existence of pre-lexical morphemic representations. This approach is in our view a ‘confirmation bias’ (Evans 1989) that can hardly support strong theoretical interpretations.

Secondly, neither the priming design used in Duñabeitia et al. 2008, nor the one constructed by Crepaldi et al. 2016 studies, permitted direct intra-comparisons. In both studies, the critical pairs are only compared to unrelated pairs and this configuration never directly tests the effect of a morphologically related prime (e.g., *baker* - *teacher*) relative to an orthographically related prime (e.g., *corner* - *teacher*) on the same target. Therefore, contrary to the interpretation proposed by these authors, their data can equally reflect greater formal

effects in the *sheeter* - *teacher* ‘morphological’ condition involving non-words than in the ‘orthographic’ *pollel* - *barrel* conditions, involving only true words.

Given the controversies raised by the exploration of affix priming effects and its implications for lexical access and for the locus of morphological effects, we decided to conduct a new masked priming experiment using real words and a protocol that permits intra-design comparisons (i.e., different prime types while keeping the same targets). We chose to run the experiments on Italian not only for its rich, productive and relatively regular morphology, but also because, being a phonetically ‘conservative’ language, at least significantly more conservative than other Romance languages where affix priming has been investigated (i.e., French), Italian has relatively long suffixes (e.g., lat. *-ittu(m)* > it. *-etto* vs. fr. *-et*, realized phonetically as [e] as in it. *muretto* vs. fr. *muret*), and thus perceptually more salient than in other languages. Moreover, in Italian suffixed words can have different prosodic contours, and suffixes may show different degrees of perceptual prominence at the prosodic level. As a matter of fact, although in Italian the great majority of suffixed words are paroxytone, i.e. stressed on the penultimate syllable, as suffixes generally carry the word stress, there is a number of proparoxytone words (i.e., stressed on the third to last syllable, when the suffix does not carry the word stress).

Finally, since Italian has undergone little phonological reduction compared to other Romance languages, it has a high degree of orthographic transparency and consistency, which can contribute to the perception and representation of functional word endings (Taft 2003).

For these reasons, we considered Italian as an ideal test language to verify suffix priming and, more specifically, the role of perceptual salience on suffixed word processing and access.

2. THE PRESENT STUDY

2.1 *Participants*

27 Italian native speakers, 22 females and 5 males, aged from 21 to 53 (mean age: 31), who reported normal or corrected-to-normal vision, participated to this experiment. All of them had high-school or university education. They were requested to participate on a voluntary basis.

2.2 *Stimuli and design*

Three productive Italian suffixes were selected: the nominal suffix *-tore*,

which combines with verbs in order to create mainly agent nouns (i.e., *viaggiare* - *viaggiatore*, ‘travel - traveller’); the adjectival suffix *-ico*, which selects nouns as stems to create relational adjectives (e.g., *nostalgia* - *nostalgico*, ‘nostalgia - nostalgic’); the evaluative suffix *-etto*, which combines with nouns to create diminutive and/or evaluative nouns³ (*pezzo* - *pezzetto* ‘piece - small piece’, *albergo* - *alberghetto* ‘hotel - small, cosy hotel’). 40 words for each suffix were selected for a total of 120 words as critical stimuli (the complete list is given in Appendix).

The suffixes *-tore*, *-ico*, *-etto* have been chosen for their different segmental and prosodic features, and also for their semantic and functional characteristics. Specifically, starting from the functional point of view, while *-tore* and *-ico* are prototypical suffixes, in that they change the category of the base and are used to create new words, *-etto*, as an evaluative, diminutive suffix, does not change the syntactic category of the base it is combined with. Indeed, for this and other aspects, a special status is generally acknowledged to evaluative morphology among word formation processes, almost at the borderline between inflexion and derivation for some scholars (for these aspects, see Grandi 2002; Grandi & Montermini 2005). Accordingly, from a semantic point of view, suffixed words in *-etto* are closer to the base, as they denote the same entity as the stem (although with an augmentative/endearment value or a diminutive/disdain value), i.e., *laghetto* ‘small lake’ is still a lake and *alberghetto* ‘small cosy hotel’ is still a hotel.⁴ However, it is important to highlight that in the *-etto* series there is a certain number of strongly lexicalized words (e.g., *collo* - *colletto* ‘neck - collar’, *corpo* - *corpetto* ‘body - corsage’, *ombra* - *ombretto* ‘shadow - eye shadow’), and others for which the semantic relationship with the base has become opaque (*scudo* - *scudetto* ‘shield - small shield’, mainly used for ‘the triangular badge assigned to the football team that wins the championship’ and then, for a semantic shift, the ‘football championship’; or *fumo* - *fumetto* ‘smoke - cartoon bubble’ and then ‘comic strip’).

Finally, the three suffixes have different degrees of functional consistency, i.e., a different proportion between suffixed and non-suffixed words in a series of words ending with a given letter string (for a discussion on consistency, see Laudanna et al. 1994). While 78% of the words ending with *-tore* and 52% of the words ending with *-ico* are suffixed, less than 40% of the words ending

³ In line with Grandi 2002, we call ‘evaluative morphology’ the morphological expression of semantic and functional relationships not only along the axis SMALL ↔ BIG but also GOOD ↔ BAD. As in other languages, in Italian diminutives and augmentatives are frequently used as expressions of endearment (*sorella* - *sorellina* ‘sister - dear little sister’) or disdain (*ragazzo* - *ragazzetto* ‘boy - little, immature boy’).

⁴ Note that, in fact, many of the true diminutives or evaluative nouns with *-etto* are not even recorded in the dictionaries (e.g., *alberghetto* ‘small, cosy hotel’ or *sughetto* ‘good, generally home-made, sauce’ are not recorded in the Sabatini & Coletti dictionary).

with *-etto* are suffixed words. Besides, in the *-etto* series, non-suffixed words (or very strongly lexicalized suffixed words) have higher frequencies (e.g., *progetto* ‘project’, *effetto* ‘effect’, *oggetto* ‘object’, *letto* ‘bed’, *aspetto* ‘aspect’, ect.) than true and transparent suffixed words.⁵ This is the reason why, if we consider tokens, the truly suffixed forms with *-etto* are even less frequent and the consistency of the sequence decreases to 16,78% (see Table 1).

For all these specific and non-prototypical features at the functional, semantic and distributional levels, *-etto* has been chosen as a sort of ‘control’ condition to compare with the prototypical behavior of the two other suffixes.

	CoLFIS	CONSISTENCY
<i>-tore</i>	865 type	78,38 %
	13671 token	86,15 %
<i>-ico</i>	1224 type	52,04 %
	22908 token	49,43 %
<i>-etto</i>	423 type	39,47%
	9261 token	16,78%

TABLE 1. QUANTITATIVE DATA RELATIVE TO THE THREE SELECTED SUFFIXES, ACCORDING TO CoLFIS (BERTINETTO ET AL. 2005) AND DERIVATARIO.

Let us now consider the perceptual salience of the suffixes. We defined it according to the following criteria:

(i) SIZE of the suffix (number of phonemes and graphemes);
(ii) DIFFERENT DEGREES of MORPHO-TACTIC TRANSPARENCY (Dressler 1985) and of phonological integration of the suffix with the stem, in particular in relation to the phenomenon of:

- resyllabification: no resyllabification takes place with *-tore* which has always two syllables independently of the stem, whereas *-ico* and *-etto*, starting with a vowel, are more integrated with the stem (respectively, [i] and [e] become the coda of the last syllable of the stem, e.g., *sto.ria* - *sto.ri.co*, ‘history - historical’, *viale* - *via.let.to* ‘avenue - alley’) and the suffixed word is resyllabified;
- morphological boundary: with *-tore* the boundary of the suffix always coincides with the boundary of the syllable, whereas with *-ico* and *-etto* the suffix is split into the two last syllables. In the Natural Morphology framework, the more the morphology overlaps with the phonological components (i.e., the higher the morpho-tactic transparency) the easier the recognition;

⁵ This distribution might also be due to the fact that evaluative nouns are mostly used in the spoken language and that corpora based on written texts (like CoLFIS) might fail to capture the size of the general process.

(iii) WORD STRESS: the suffixes *-tore* and *-etto* always carry the word stress, while *-ico* does not. Moreover, words with *-tore* and *-etto* show the more frequent stress pattern in Italian (about 80% of the words carry the word stress on the penultimate syllable, see Thornton et al. 1997; Burani & Arduino 2004; Giraudo & Montermini 2010, on the effect of regularity and consistency of patterns in stress assignment for Italian words).

According to these criteria, *-tore* is the most perceptually salient suffix and *-etto* is more salient than *-ico*.

Starting from these assumptions, in the first experiment we will verify: (a) whether words with a perceptually salient suffix such as *-tore* are recognized faster than words with a less salient suffix such as *-ico* when primed by a word with the same suffix. If this is the case, the word *narratore* ‘teller’ should prime *viaggiatore* ‘traveller’ better than *ironico* ‘ironic’ primes *atomico* ‘atomic’; (b) whether a word belonging to a more consistent word ending series (like *-tore*) is recognized faster than a word belonging to a less consistent word ending series (like *-etto*). According to this hypothesis, we expect higher priming effects for words with *-tore* than for words with *-etto*.

In our experimental design, summarized in Table 2, the suffix condition (our test condition), i.e., the effect of the presentation of a suffixed word as a prime on the recognition of a complex target word with the same suffix, is considered in relation to three other conditions: (i) the identity condition, which should yield the most significant facilitation effect and consequently the shortest RTs, (ii) the unrelated condition which, on the contrary, is expected to yield the smallest facilitation effect and the longest RTs and (iii) a base condition, which allows us to contrast the strength of the connection between words with the same suffix (i.e., same morphological schema) with the strength of the connection between words sharing the same stem (i.e., same morphological family).

SUFFIXES	IDENTITY CONDITION	SUFFIX CONDITION	BASE CONDITION	UNRELATED CONDITION	TARGETS
<i>-tore</i>	<i>pescatore</i> ‘fisherman’ (37.13)	<i>traditore</i> ‘traitor’ (30.63)	<i>pescare</i> ‘to fish’ (248.87)	<i>colomba</i> ‘dove’ (37.12)	PESCATORE
<i>-ico</i>	<i>nostalgico</i> ‘nostalgic’ (39.98)	<i>sinfonico</i> ‘symphonic’ (38.28)	<i>nostalgia</i> ‘nostalgia’ (284.95)	<i>approccio</i> ‘approach’ (40.70)	NOSTALGICO
<i>-etto</i>	<i>pezzetto</i> ‘small piece’ (3.32)	<i>boschetto</i> ‘grove’ (4.82)	<i>pezzo</i> ‘piece’ (284.32)	<i>ombelico</i> ‘navel’ (9.08)	PEZZETTO

TABLE 2. EXAMPLE OF CRITICAL MATERIALS USED FOR THE EXPERIMENT (WITH MEAN FREQUENCIES IN OCCURRENCES PER MILLION ACCORDING TO THE COLFIS DATABASE). PRIMES AND TARGETS WERE MATCHED FOR LENGTH (RESPECTIVELY 7.67 AND 9.25 LETTERS).

120 complex non-word targets constructed from the combination of a non-existing stem + either the suffix *-tore* (e.g., *dinfatore*), or the suffix *-ico* (e.g., *tuzzico*) or the suffix *-etto* (e.g., *giufretto*), were created for the purposes of the lexical decision task. Each non-word target has been primed in the same four priming conditions: identity (e.g., *dinfatore* - *dinfatore*), suffix (e.g., *lempitore* - *dinfatore*), base (e.g., *dinfare* - *dinfatore*) and unrelated (e.g., *firmeca* - *dinfatore*).

Four experimental lists, each composed of 240 prime-target pairs (half words and half non-words), were created by rotating targets across the four priming conditions using a Latin-square design, so that each target appeared only once for a given participant, but was tested in all priming conditions across participants. Participants were randomly assigned to one of the four lists.

2.3 Procedure and apparatus

The experiment was conducted on a PC computer using the DMDX software (Forster & Forster 2003). Each trial consisted of three visual events. The first was a forward mask consisting of a row of nine hash marks that appeared for 500 ms. The mask was immediately followed by the prime. The prime was, in turn, immediately followed by the target word, which remained on the screen until participants responded. The prime duration used in this experiment was 50 ms. Primes and targets were presented both in lowercase characters but using different fonts (primes in Arial 12 and targets in Courier 12). Participants were seated 50 cm from the computer screen and were requested to make lexical decisions on the targets (“is it a word? Yes/No”), as quickly and as accurately as possible, by pressing the appropriate button of the keyboard. They were unaware of the fact that primes would appear after the mask and before the target, since the duration of the prime would prevent conscious identification. After 20 practice trials, participants received 240 items in two blocks.

3. RESULTS

Response times (RTs) of correct decisions were averaged across participants after excluding outliers (RTs >1500 ms, 0.55% of the data). Results are presented in Table 3. An ANOVA was performed on the remaining data with prime type factor (identity, suffix, base and unrelated primes) and suffix type (*-tore*, *-ico* and *-etto*) as within-participant factors. 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 experiment; therefore,

as recommended by Raaijmakers & Phaf (1999), we did not perform separate subject and item analyses but only a *F*1 test statistic.

SUFFIX TYPE	PRIME TYPE				NET PRIMING EFFECTS (MS)		
	IDENTITY	SUFFIX	BASE	UNRELATED	U-I	U-SUFFIX	U-BASE
<i>-TORE</i>	684 (0.42)	715 (1.25)	672 (0.42)	717 (0.31)	-33*	-2	-42*
<i>-ICO</i>	675 (1.04)	715 (1.04)	671 (0.83)	729 (1.35)	-54*	-14	-58*
<i>-ETTO</i>	698 (4.58)	757 (5.52)	717 (2.92)	735 (4.69)	-37*	+22	-18

TABLE 3. REACTION TIMES (RTs, IN MILLISECONDS) FOR LEXICAL DECISIONS TO SUFFIXED WORD TARGETS ENDING IN *-TORE*, *-ICO*, *-ETTO*, WITH NET PRIMING EFFECTS RELATIVE TO THE UNRELATED PRIME CONDITIONS. (* = *p*-VALUE < .05).

The main effects of the prime type factor ($F(3,78) = 13.168$, *p*-value < .0001) and the suffix type factor ($F(2,52) = 13.154$, *p*-value < .0001) were significant. However, the interaction between these two factors was not significant ($F(6, 156) = 1.078$, *p*-value > .10). However, the prime type factor interacted partially with the suffix types (*-tore*: $F(3,75) = 6.86$, *p*-value > .001; *-ico*: $F(3,75) = 7.57$, *p*-value < .001; *-etto*: $F(3,75) = 4.01$, *p*-value < .05). Planned pairwise comparisons were performed for each suffix type:

- For *-tore* targets, both identity and base primes induced priming relative to the unrelated control condition ($F(1,25) = 7.47$, *p*-value < .05 and $F(1,25) = 17.19$, *p*-value < .05 respectively) while suffix primes did not ($F(1,25) < 1$). Moreover, identity primes did not differ from base primes ($F(1,25) = 1.56$, *p*-value > .10).
- For *-ico* targets, the same pattern of priming as for *-tore* was observed. Relative to the unrelated baseline, only identity and base primes facilitated target recognition ($F(1,25) = 8.50$, *p*-value > .05 and $F(1,25) = 12.25$, *p*-value < .05, respectively) and these two conditions did not differ from each other ($F(1,25) < 1$). Suffix primes did not induce significant priming ($F(1,25) = 0.61$, *p*-value > .10).
- For *-etto* targets, the results were slightly different: only identity primes induced a significant facilitation effect relative to the unrelated condition ($F(1,25) = 4.01$, *p*-value < .05), but not to the base condition ($F(1,25) = 1.52$, *p*-value > .10). Nevertheless, despite producing shorter mean RTs (-18 ms), base primes were not able to produce a significant priming effect relative to the unrelated primes ($F(1,25) = 0.67$, *p*-value > .10). Suffix primes produced longer mean RTs (+22 ms), but this effect was not significant ($F(1,25) = 2.31$, *p*-value > .10).

Finally, no significant partial interaction effect was found between suffix type and the identity condition or unrelated baseline condition (respectively, $F(1,250) = 0.56$, *p*-value > .10 and $F(1,250) = 1.43$, *p*-value > .10), but a significant partial interaction effect between suffix type and both the suffix and

the base conditions ($F(2,50) = 5.97$, $p\text{-value} < .05$ and $F(2,50) = 9.34$, $p\text{-value} > .05$).

As we can see from Table 3, our results reveal a clear priming effect for the identity and base conditions with respect to the unrelated condition for words ending with *-tore* and with *-ico*.

On the other hand, with *-etto*, we found a priming effect for the identity condition but a less clear-cut facilitation effect for the base condition. These data should be considered in relation to the error rate, which is higher for words with *-etto* than for the others (see Table 3, values in brackets).

As for the suffix condition, which was our test condition, none of the suffixes considered induced priming, i.e., the presentation of a suffixed word as a prime did not yield any facilitation effect on the recognition of a complex target word with the same suffix. More importantly, the observed lack of facilitation is independent of the salience of the suffix, as the most salient (at least according to our parameters) suffix *-tore* did not induce faster RTs than the less salient *-ico* (e.g., *viaggiatore -narratore* did not work better than *ironico-storico*). Therefore, as for the first research question, it can be stated that no suffix priming effect emerged from our experiment, at least in relation to the different degree of suffix perceptual salience, and that words with a perceptually salient suffix (such as *-tore*) are not recognized faster than words with a less salient suffix (such as *-ico*) when primed by a word with the same suffix. These results are compatible with Giraudo and Grainger's findings on French, and show that the lack of suffix priming that they observed was not due to the fragility of the perceptual body of the suffix, since even in a language with more perceptually salient (i.e., longer and mainly stressed) suffixes the effect of the suffix failed to emerge.

The second research question was to determine whether a word belonging to a more consistent word ending series (*-tore*) is recognized faster than a word belonging to a less consistent word ending series (*-etto*). According to this hypothesis, we expected higher priming effects for words with *-tore* than for words with *-etto*. From our results, not only the suffix *-etto* failed to produce significant effects (as found for the other two suffixes), it also yielded even longer RTs with respect to the unrelated condition. In our view, this suggests a sort of inhibition effect in the suffix condition.

More interestingly, if we look at the general pattern of activation, we can observe that, while with functionally consistent series we found a strong effect of the base, with *-etto* we failed to obtain even the base effect. It seems that the 'ambiguity' of the sequence *-etto* (which is a suffix only in 40% of the words which have this word ending and has non-prototypical functional and semantic properties) makes it more difficult to identify the stem, i.e., to decide whether the first part of the word is in fact a stem. On the contrary, with *-tore*,

given that the string constitutes a suffix in the great majority of cases (80%), the preceding part is more likely to be a real stem and consequently more easily recognized as such. This effect might be strengthened by the fact that, as pointed out earlier, truly and transparent suffixed words with *-etto* generally have low frequencies, while the most frequent words of this series are non-suffixed or strongly lexicalized words. This result suggests that what has been observed about prefixes by Laudanna et al. 1994 proves to be true also for suffixes, i.e., the recognition of a suffixed word varies according to the consistency of the series it belongs to. Moreover, our study demonstrates that not only the likelihood of the sequence to be recognized as an affix (a suffix, in our case) depends on the quantitative relation between affixed and non-affixed words, but also and crucially that even the recognition of the stem is affected by the series consistency. Taken together, these results can be considered as a confirmation of our hypothesis on functional (in)consistency for the *-etto* series, opposed to the *-tore* and *-ico* series.

In a more general perspective, our present study contributes to the body of evidence demonstrating that subjects are influenced by the statistical nature of the language they are exposed to, and supports models of morphological processing that are sensitive to the statistical nature of the systematic mapping between form and meaning among words in a given language (Bybee 1988, 1995; Booij 2010; Baayen et al. 2011).

4. DISCUSSION AND IMPLICATIONS

As we pointed out, the lack of suffix priming in our masked-priming experiment replicates Giraudo and Grainger's findings for French (Experiment 1), suggesting that their difficulty to obtain a suffix priming effect experimentally is not simply due to the specific (morpho-phonological) features of French. The interpretation of our results can be twofold. On the one hand, they can suggest that the mental lexicon is organized in morphological families and in prefixed series (Giraudo & Grainger 2003; Chateau et al. 2002), but not in suffixed series. However, this hypothesis not only contradicts native speakers' *naïf* insights, but also, and more importantly, is not compatible with the functional weight of suffixation in Italian. In a more general way, the resistance of suffix priming to emerge in many languages is at odds with what is called 'sufficing preference' in typological studies, i.e., the fact that among the world's languages suffixes are largely preferred to prefixes (Hawkins & Giligan 1988: 219). Finally, the emergence of suffix priming effects is also expected according to the simulations conducted by Baayen et al. 2011 with an 'amorphous' model (i.e., even in a model without morphology), which

demonstrated that a large and consistent formal and semantic overlapping between primes and targets ('whether or not this sharing is brought about by means of affixation', Baayen 2014: 11) is the optimal condition to observe strong priming effects.

However, the fact that suffix priming did not emerge in our experiment does not necessarily mean that there is no suffix effect, which would correspond to the confirmation of the 'null hypothesis'. In this sense, the lack of suffix priming effects in experimental data constitutes a crucial challenge to any model of morphological processing and lexical access.

In the light of all these considerations, we can propose an alternative hypothesis to explain the lack of suffix priming effects, i.e., the 'functional' meaning carried by the suffix might need more activation to emerge with respect to the lexical meaning of the stem, which, on the contrary, is easily captured (in the sense of being represented as an emergent unit) and indeed produces very strong priming (except for the very special case of words ending in *-etto*). In this line of reasoning, it would be possible to explain why suffix priming emerged, although in a single study, with an experimental technique that taps deeper lexical representations. We refer to the study of Marslen-Wilson et al. 1996 in which a cross-modal technique (i.e., auditory primes with visual targets) has been used. This methodological aspect does not seem irrelevant to us: cross-modal priming, reflecting repeated access to the lexical representations shared by prime and target, taps more directly into the stage of representations at the level of lexical entry. The cross-modal priming technique, however, has other drawbacks, namely the fact that primes are consciously perceived by participants, and consequently the recourse to response strategies cannot be excluded. On the other hand, masked priming is more suited to capture the automatic processes involved in lexical access but, especially when associated with a lexical decision task, is more sensitive to formal and surface-oriented effects (see Baayen 2014, for a discussion). In this sense, a task less focused on formal aspects than the discrimination between words and non-words in lexical decision, i.e., category decisions, could more easily allow functional effects to emerge within the masked priming paradigm.

In addition, if we explain the lack of suffix priming by advocating the functional nature of the affix (vs. the lexical stem), we need to take into consideration that masked priming worked efficiently with prefixes (Giraudo & Grainger 2003). Formal positional factors also need to be acknowledged as elements affecting the processing; however, at this point of the research it is not possible to disentangle the effect of purely positional factors from functional ones. This should constitute further development for future research. With respect to this point, our results suggest that in the domain of affixation,

the functional aspects need to be investigated in more detail as they can produce different patterns of activation in priming mechanisms and originate different effects in processing.

It is noteworthy that this kind of interpretation, which accounts also for the different nature of the morphological entities, is incompatible with a purely compositional approach, in which lexical access is mainly based on the parsing of all forms into surface morphemes and where the only determinant factor for lexical access is decompositionability. Accordingly, in a strictly decompositional approach, both stems and affixes are acknowledged to have an equal status of access units during word recognition (Duñabeitia et al. 2008). Therefore, all morphemes (i.e., prefixes, stems and suffixes) should produce equivalent priming effects, which does not seem to be the case if we consider our data.

5. CONCLUSIONS

The aim of our research was to verify whether suffixes and morphological schemas play a role in the access and processing of Italian complex words like stems do, and, more precisely, whether suffix salience affects such a process. The three suffixes *-tore*, *-ico* and *-etto* have been selected for their perceptual characteristics and for the functional consistency of their series. According to the salience parameters selected, i.e., size, morpho-tactic transparency and word stress, *-tore* has been considered as the most salient suffix, while *-ico* the less salient one. On the other hand, according to the ratio of true suffixed words in a given word ending series, *-tore* and *-ico* have been considered more consistent series than the one with *-etto*. A masked priming experiment has been carried out with Italian native speakers, in which suffixed target words were primed in four different conditions: an identity condition, a base condition, a suffix condition and an unrelated condition. Results indicate that no suffix priming effect emerges, i.e., the recognition of the suffixed word primed by a word with the same affix (e.g., *traditore* - *pescatore*) is not significantly faster with respect to the condition in which it is primed by an unrelated word (e.g., *colomba* - *pescatore*). Moreover, this result is independent of the salience of the suffix.

On the contrary, the consistency of the series seems to play a role in processing, although in a quite indirect way. As a matter of fact, while the suffix condition did not reveal any effect for *-tore* and *-ico* compared to the unrelated condition, for the *-etto* series it yielded a sort of inhibitory effect, i.e., longer RTs compared to the unrelated primes. More interestingly, the base condition, which emerged very clearly with *-tore* and *-ico*, failed to emerge with *-etto*. The distributional properties, together with the non-prototypical

semantic and functional characteristics of *-etto* seem therefore to affect also the relation between the base and the suffixed word.

The reasons of the lack of suffix priming have been discussed mainly in relation to the ‘nature’ of suffix meaning, proposing that the different nature of morphological entities might imply different priming effects and that suffixes might need more activation than prefixes to emerge. As we recognize that suffixes operate at a functional level and that a suffixed word is not simply the sequence of two superficial morphemes with equivalent status, suffix priming might emerge with tasks less focused on formal aspects within the masked priming paradigm (semantic decision instead of lexical decision task).

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APPENDIX

LIST OF STIMULI USED IN OUR EXPERIMENT

-TORE

TARGETS	IDENTITY	SUFFIX	BASE	UNRELATED
navigatore	navigatore	ispiratore	navigare	sgabello
intervistatore	intervistatore	borseggiatore	intervistare	piattaforma
accompagnatore	accompagnatore	sceneggiatore	accompagnare	pastasciutta
allenatore	allenatore	peccatore	allenare	cappello
vincitore	vincitore	spalatore	vincere	calamita
truccatore	truccatore	restauratore	truccare	conchiglia
venditore	venditore	seduttore	vendere	conforto
cacciatore	cacciatore	predicatore	cacciare	ergastolo
viaggiatore	viaggiatore	fondatore	viaggiare	scheletro
risparmiatore	risparmiatore	collaboratore	risparmiare	corrispondenza
fumatore	fumatore	elettore	fumare	pentola
traditore	traditore	informatore	tradire	forchetta
scalatore	scalatore	ricercatore	scalare	labirinto
guidatore	guidatore	protettore	guidare	scintilla
disegnatore	disegnatore	prestigiatore	disegnare	indifferenza
donatore	donatore	calciatore	donare	ombrello
suonatore	suonatore	pescatore	suonare	minestra
esploratore	esploratore	rapinatore	esplorare	caramella
suggeritore	suggeritore	portatore	suggerire	campana
educatore	educatore	servitore	educare	colomba
sciatore	sciatore	imitatore	sciare	insalata
narratore	narratore	sognatore	narrare	petrolio
visitatore	visitatore	creatore	visitare	parrocchia
osservatore	osservatore	conquistatore	osservare	principiante
sostenitore	sostenitore	massaggiatore	sostenere	graduatoria
spacciatore	spacciatore	assicuratore	spacciare	cioccolato
gestore	gestore	nuotatore	gestire	torrente
mediatore	mediatore	guaritore	mediare	ostaggio
ascoltatore	ascoltatore	provocatore	ascoltare	soggiorno
ammiratore	ammiratore	contestatore	ammirare	antenato
presentatore	presentatore	albergatore	presentare	ballottaggio
commentatore	commentatore	utilizzatore	commentare	enciclopedia
compratore	compratore	adoratore	comprare	stupefacente
fornitore	fornitore	divulgatore	fornire	prodigio
ideatore	ideatore	arredatore	ideare	tovaglia
accusatore	accusatore	addestratore	accusare	menzogna
truffatore	truffatore	animatore	truffare	cespuglio
allevatore	allevatore	consumatore	allevare	porcellana
soccorritore	soccorritore	assaggiatore	soccorrere	controversia
organizzatore	organizzatore	parcheggiatore	organizzare	giurisprudenza

-ICO

TARGETS	IDENTITY	SUFFIX	BASE	UNRELATED
problematico	problematico	terapeutico	problema	inchiostro
acquatico	acquatico	magnetico	acqua	schiaffo
sistematico	sistematico	diabolico	sistema	groviglio
programmatico	programmatico	enigmatico	programma	incantesimo
climatico	climatico	sintetico	clima	vagabondo
traumatico	traumatico	ipotetico	trauma	prestigio
asiatico	asiatico	poetico	Asia	antenna
aromatico	aromatico	ecologico	aroma	singhiozzo
carismatico	carismatico	filosofico	carisma	bersaglio
alfabetico	alfabetico	genetico	alfabeto	privilegio
categorico	categorico	selvatico	categoria	prosciutto
periferico	periferico	monarchico	periferia	triangolo
nostalgico	nostalgico	sinfonico	nostalgia	approccio
teorico	teorico	lirico	teoria	agnello
strategico	strategico	frenetico	strategia	formaggio
malinconico	malinconico	dietetico	malinconia	veterinario
ironico	ironico	atomico	ironia	colera
cilindrico	cilindrico	euforico	cilindro	ingrediente
allergico	allergico	esotico	allergia	virgola
magico	magico	generico	magia	banana
numerico	numerico	ebraico	numero	incrocio
scenico	scenico	tragico	scena	fontana
nordico	nordico	elettrico	nord	verdura
panoramico	panoramico	nevrotico	panorama	semaforo
atmosferico	atmosferico	cromatico	atmosfera	meraviglia
oceanico	oceanico	ritmico	oceano	coperta
periodico	periodico	armonico	periodo	materasso
telefonico	telefonico	patetico	telefono	coniglio
simbolico	simbolico	metodico	simbolo	quercia
eroico	eroico	isterico	eroe	bambola
atletico	atletico	termico	atleta	maestra
canonico	canonico	melodico	canone	padella
satirico	satirico	ipnotico	satira	mignolo
catastrofico	catastrofico	anagrafico	catastrofe	maggiordomo
metallico	metallico	angelico	metallo	binario
mitico	mitico	caotico	mito	garante
vulcanico	vulcanico	schematico	vulcano	margherita
igienico	igienico	tematico	igiene	tulipano
accademico	accademico	simpatico	accademia	pergamena
cosmico	cosmico	satánico	cosmo	bottone

-ETTO

TARGETS	IDENTITY	SUFFIX	BASE	UNRELATED
violetto	violetto	bauletto	viale	sberla
armadietto	armadietto	gamberetto	armadio	proboscide
sorrisetto	sorrisetto	mazzetto	sorriso	trambusto
animaletto	animaletto	braccialeto	animale	crepuscolo
sughetto	sughetto	lavoretto	sugo	papavero
colpetto	colpetto	legnetto	colpo	mirtillo
alberghetto	alberghetto	tesoretto	albergo	chiocciola
scolaretto	scolaretto	baronetto	scolaro	germoglio
baretto	baretto	muletto	bar	scrigno
bulletto	bulletto	capetto	bullo	bisturi
giardinetto	giardinetto	blocchetto	giardino	sgualdrina
gruppetto	gruppetto	mesetto	gruppo	granchio
giornaletto	giornaletto	vecchietto	giornale	arcobaleno
fiocchetto	fiocchetto	broccioletto	fiocco	lampadario
orsetto	orsetto	nanetto	orso	dinamite
cancelletto	cancelletto	bronzetto	cancello	lenticchia
dolcetto	dolcetto	musetto	dolce	pasticca
genietto	genietto	fighetto	genio	caraffa
discorsetto	discorsetto	martelletto	discorso	mozzarella
quadretto	quadretto	buchetto	quadro	cetriolo
vizietto	vizietto	cagnetto	vizio	scontrino
cavetto	cavetto	ovetto	cavo	malaria
faretto	faretto	paggetto	faro	canguro
borghetto	borghetto	calcetto	borgo	tranello
laghetto	laghetto	ometto	lago	bidello
specchietto	specchietto	giubbetto	specchio	coriandolo
mesetto	mesetto	tubetto	mese	fracasso
palchetto	palchetto	dischetto	palco	garofano
campetto	campetto	cubetto	campo	faggio
falchetto	falchetto	maschietto	falco	scompiglio
galletto	galletto	palazzetto	gallo	sepolcro
coretto	coretto	paletto	coro	muschio
tacchetto	tacchetto	funghetto	tacco	bistecca
giochetto	giochetto	affaretto	gioco	astuccio
pezzetto	pezzetto	boschetto	pezzo	ombelico
foglietto	foglietto	mobiletto	foglio	grandine
vasetto	vasetto	giretto	vaso	flamenco
stivaletto	stivaletto	pranzetto	stivale	pagliaccio
rametto	rametto	divanetto	ramo	cannella
zainetto	zainetto	carretto	zaino	vascello