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Influence of verb and noun bases on reading aloud derived nouns: evidence from children with good and poor reading skills

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Abstract Several studies on children and adults with and without linguistic impairment have reported differences between verb and noun processing. The present study assessed whether noun and verb bases affect differently children's reading of derived words. Thirty-six Italian good readers and 18 poor readers, all 4th or 5th graders, were asked to read aloud nouns derived from either a noun base (e.g., *artista*, artist) or a verb base (e.g., *punizione*, punishment). Word and base frequency affected latencies only for deverbal nouns, while an effect of word length emerged for denominal nouns and an inhibitory effect of suffix length was found for both types of stimuli. A high base frequency and a high whole-word frequency both led to higher levels of accuracy. Verb bases led to higher error rates than noun bases. Poor readers, although slower and less accurate than good readers, showed a pattern of results similar to that of typically developing readers. Data confirm that in 4th and 5th graders morphological decomposition may affect reading aloud of long complex words, and that the grammatical class of the base can modulate this effect.

Keywords Reading acquisition · Morphology · Grammatical category

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Introduction

Since Taft and Forster's (1976) seminal paper, morphological effects on word recognition have been reported in several studies and substantial evidence supports the hypothesis that complex words may activate both full form representations and morphemic constituents (e.g., Alegre & Gordon, 1999; Baayen, Burani, & Schreuder, 1997a; Baayen, Dijkstra, & Schreuder, 1997b; Burani & Thornton, 2003; Katz, Rexer, & Lukatela, 1991; Sereno & Jongman, 1997). More recently, new evidence has emerged in support of a similar hybrid model, suggesting that the chances of successfully achieving word recognition can be maximised through simultaneous processing of whole-word and morphemic representations (Beyersmann, Coltheart, & Castles, 2012; Feldman, O'Connor, & Moscoso del Prado Martin, 2009).

Many properties of both words and morpheme constituents can favour either access through morphemic decomposition or whole word processing. The semantic and phonological transparency of a morphologically complex word with respect to its base (Baayen, 1991; Diependaele, Sandra, & Grainger, 2009; Feldman et al., 2009; Marslen-Wilson, Tyler, Waksler, & Older, 1994) and the number of derived and compound words sharing the same base (*derivational and compounding family size*: Bertram, Baayen, & Schreuder, 2000; de Jong, Schreuder, & Baayen, 2000; Kuperman, Schreuder, Bertram, & Baayen, 2009) have emerged as important variables affecting word processing. It has also been assumed that morphemic parsing is more likely to occur when the frequency of the whole word is lower than the frequency of its morphological components (Burani & Laudanna, 1992; Chialant & Caramazza, 1995; Colé, Beauvillain, & Segui, 1989), and when a suffix is long, productive, and has no homophonic forms (Bertram, Laine, Baayen, Schreuder, & Hyöna, 1999; Kuperman, Bertram, & Baayen, 2010; Plag & Baayen, 2009). Recently, Ford, Davis and Marslen-Wilson (2010) reported a study that assessed the roles of whole-word frequency, base morpheme frequency, affix productivity, and family size on visual lexical decision response times to derived words in the English language. Only words with productive suffixes showed independent facilitatory effects of both base morpheme frequency and family size, over and above the whole-word frequency effect. However, Burani and Thornton (2003) observed that, in the recognition of low frequency derived words with a productive suffix, morphemic parsing is favoured mainly by the base frequency, since only low frequency words with a high-frequency base could be recognized faster than simple words matched for whole-word frequency, irrespective of the frequency of the suffix.

Access to morphemic constituents can improve reading performance during literacy acquisition. With regard to English, Mann and Singson (2003) and Carlisle and Stone (2005) found that derived words with a high frequency base are read with greater accuracy than derived words with a low frequency base matched for surface frequency. Deacon, Whalen and Kirby (2011) took into account surface frequency, base frequency and the phonological/orthographical transparency of the base, and found that children in grades 4 and 6 were able to read aloud words with a high frequency base more accurately than those with a low frequency base, while an effect of transparency emerged only for words with a low surface frequency. Children in grades 4, 6, and 8 read derived words with a high frequency base faster than those with a low frequency base, but only in the case of words with a low surface frequency, and the effect was greater for children in grades 4 and 6.

A number of studies conducted in Italian, a language with transparent orthography, have shown that young readers in this language also take advantage of the presence of base morphemes when reading aloud both words and pseudowords (Burani, Marcolini, De Luca, & Zoccolotti, 2008; Burani, Marcolini, & Stella, 2002; Marcolini, Traficante, Zoccolotti, & Burani, 2011; Traficante, Marcolini, Luci, Zoccolotti, & Burani, 2011). In languages with a transparent orthography like Italian and German, readers with poor decoding skills mostly employ an analytical and fractionated text scanning approach, based on reading units with a small grain size (De Luca, Borrelli, Judica, Spinelli, & Zoccolotti, 2002; De Luca, Di Pace, Judica, Spinelli, & Zoccolotti, 1999; Hutzler & Wimmer, 2004). Morpheme-based reading seems to be particularly useful for these readers, since the possibility of identifying a known base at the beginning of a long word could facilitate their performance.

Evidence on the role of morphemic constituents in word processing is quite consistent. However, notwithstanding the vast amount of data indicating the presence of grammatical class differences in language processing, studies on the processing of derived words have only rarely taken into account the grammatical class of the base word. For instance, there is a substantial body of evidence documenting the difficulty in learning and producing verb forms in specific language impairment (SLI) (Black & Chiat, 2003; Chiat, 2000). Conti-Ramsden and Jones (1997) found reduced verb (but not noun) production in children with SLI, who tended to use uninflected verbs. A peculiar deficit in inflecting verbs for tense was observed in children with developmental dyslexia, both in groups with a previous diagnosis of SLI (Joanisse, Manis, Keating, & Seidenberg, 2000) and in children without difficulties in early language acquisition (Marshall, Harcourt-Brown, Ramus, & van der Lely, 2009), while Egan and Pring (2004) found that children with dyslexia were slower at reading and less accurate at spelling regularly inflected verbs.

A relevant source of evidence for the difference in verb versus noun processing comes from neuropsychological studies on adults suffering from acquired language disorders. Several studies found a disproportionate impairment in comprehension and/or production of simple nouns and verbs (Chen & Bates, 1998; Crepaldi et al. 2006; Luzzatti, Raggi, Zonca, Pistarini, Contardi, & Pinna, 2002; Zingeser & Berndt, 1990). Other studies aimed at localizing different cortical areas involved in verb and noun processing (e.g., Aggujaro, Crepaldi, Pistarini, Taricco, & Luzzatti, 2006; Daniele, Giustolisi, Silveri, Colosimo, & Gainotti, 1994; see for a review Crepaldi, Berlingeri, Paulesu, & Luzzatti, 2011).

The processing disadvantage of verbs compared to nouns is to be attributed to several semantic and syntactic properties: overall, verbs are acquired later (D'Odorico, Carubbi, Salerni, & Calvo, 2001; D'Odorico & Fasolo, 2007; Kauschke, Lee, & Pae, 2007), are less imageable (Chiarello, Shears, & Lund, 1999), and have a more complex syntactic structure than nouns (Kim & Thompson, 2000).

In addition to these semantic and syntactic properties, the inflectional characteristics of verbs may contribute to their processing peculiarities. Sereno and Jongman (1997), conducting a lexical decision task, found that participants recognized nouns faster than verbs and suggested that this could be due to the different inflectional distribution of noun and verb forms in English: in the Brown Corpus (Francis & Kučera, 1982) the base forms of nouns account for approximately 74 % of the total frequency of the noun lemma, while the base forms of verbs constitute only 29 % of the total verb lemma. Differences in the processing of different grammatical categories also emerged in languages with a richer morphology than English. Kostić and Katz (1987) proposed that the differences in lexical decision times found for nouns, adjectives, and verbs in Serbo-Croatian were related to the number of inflectional alternatives for each grammatical class. Differences between verbs and nouns were found also in Hebrew (Deutsch, Frost, & Forster, 1998), and the authors suggested that in addition to semantic and syntactic considerations, the distributional properties of constituents may account for their lexical role: "When a morpheme is common to more words in the language, its impact on processes of morphological decomposition is prominent" (Deutsch et al., 1998, p. 1252).

In Italian, individuals tend to recognize and read verbs aloud more slowly than nouns and adjectives, and RTs for verbs, but not for nouns or adjectives, are correlated with their base frequency (Colombo & Burani, 2002; Traficante, Barca, & Burani, 2004; Traficante & Burani, 2003). To account for this pattern of data, Traficante and Burani (2003) proposed a role for the inflectional family size of a word: the higher the number of inflected forms linked to a given base, the slower the processing of each individual inflected form. If the inflectional family is large, it is highly possible that the verbs are read and recognized through their morphemic constituents, and competition among inflected word forms may arise.

The Italian language is particularly suitable for assessing this hypothesis. Inflectional paradigms of Italian verbs show approximately 50 inflections (varying by aspect, person, mood, and tense) for each of the three main inflectional paradigms[1] (Table 1), while the most part of noun bases combine with only two inflectional suffixes (number: singular vs. plural, e.g., *casa/case*, house/houses) and adjective bases with up to four inflectional suffixes (gender: masculine vs. feminine, e.g., *bello/bella*; number: singular vs. plural, e.g., *bella/belle*, beautiful).

In line with this view, Laudanna, Voghera and Gazzellini (2002), applying a priming technique in a lexical decision task, reported that noun (e.g., *cost-e*$_{[N]}$, "coasts") and verb (e.g., *boll-ato*$_{[V]}$, "stamped") primes embedding a base form homographic to the base of the target, exert an inhibitory effect on target recognition only when the target is a verb (respectively, *cost-ava*$_{[V]}$, "cost", *boll-ire*$_{[V]}$, "to boil"), while the inhibitory effect is not consistently present in the case of noun targets, either in case of a verb base prime (e.g., *stil-are*$_{[V]}$, "to draft"/*stil-e*$_{[N]}$, "style"), or in the case of a noun base prime (e.g., *mod-e*$_{[N]}$, "fashions"/*mod-i*$_{[N]}$,

[1] The inflected forms of Italian verb are parsable in three main constituents: the root, the thematic vowel, and the inflectional suffix (e.g., *gioc-a*-va, he/she *play*ed). In this paper the root + thematic vowel combination is defined as base. There are three different inflectional paradigms, characterized by the three different thematic vowels: -*a* (1st paradigm: e.g., *parl-a*-re, to speak), -*e* (2nd paradigm; e.g., *legg-e*-re, to read), -*i* (3rd paradigm: e.g., *part-i*-re, to leave).

Table 1 Verb paradigm in Italian: personal and impersonal forms in simple tenses

Mood	Simple tenses	Suffixes		Example[a]
		Singular	Plural	
Indicative	Present	-o, -i, -a/-e	-iamo, -te, -no	Voi *parti*-te, you leave, you are leaving
	Imperfect	-vo, -vi, -va	-vamo, -vate, -vano	Voi *parti*-vate, you left/you used to leave/you were leaving
	Future	-rò, -rai, -rà	-remo, -rete, -ranno	Voi *parti*-rete, you will leave
	Preterite	-i, -sti, -ò/-e/-ì	-mmo, -ste, -rono/-ero	Voi *parti*-ste, you left (historic)
Conditional	Present	-rei, -resti, -rebbe	-remmo, -reste, -rebbero	Voi *parti*-reste, you would leave
Subjunctive	Present	-i/-a	-iamo, -iate, -ino	(che) Voi *parti*-(i)ate, (that) you leave
	Imperfect	-ssi, -sse	-ssimo, -ste, -ssero	(che) Voi *parti*-ste, (that) you left
Imperative	Present	-a/-i	-te	*Parti*-te!, leave!
Infinitive	Present	-re		*Parti*-re, to leave
Gerund	Present	-ando/-endo		*Part*-endo, leaving
Participle	Present	-ente		*Part*-ente, leaving
	Past	-to		*Parti*-to, left

[a] The examples show verb infected forms for the 2nd plural person of a 3rd conjugation verb

"manners"). The authors claim that in the Italian orthographic lexicon verbs are likely to be represented in decomposed form, while nouns are represented both as whole words and in decomposed form; the interplay of certain parameters (e.g., morphological complexity, whole-word frequency, and base frequency) determines which representation is activated first.

Overall, it can be assumed that in several languages verbs, due to their inflectional characteristics, are more likely to be parsed into morphemes than nouns, and as a consequence verb roots are more likely to be accessed as reading units than noun roots.

The objective of the present study is to assess whether suffixed derived words, similarly to inflected words, are more likely to be parsed into a base root and a derivational suffix when they have a verb base than when they have a noun base. It is reasonable to hypothesize that the differences in processing between derived words with verb bases and noun bases would be most pronounced in poor readers who, given the difficulty they have in accessing whole word representations, are prone to an extensive recourse to morphemic units when reading aloud. In order to verify whether Italian children, and specifically poor readers, are more likely to parse a suffixed derived word in morphemes when it includes a verb base than when it includes a noun base, we investigated the role of the base frequency of the derived word. We expected to find that the frequency of the base would exert a greater influence on the reading performance for words derived from a verb base than for words with a noun base, while the frequency and length characteristics of the

Table 2 Means and standard deviations for age in months, scores at the Raven's Progressive Matrices, z-scores on reading speed and accuracy in the MT reading test, for poor and good readers

	Poor readers		Good readers	
	M	*SD*	*M*	*SD*
Chronological age	121.39	6.75	122.83	8.48
Raven's Progressive Matrices	26.83	4.57	27.56	3.34
Reading speed in MT test	1.89	0.38	−0.46	0.21
Reading accuracy in MT test	0.54	0.78	−0.39	0.47

whole-word were expected to have a greater effect on reading words derived from a noun base than from a verb base.

Method

Participants

The reading levels of 286 children attending the 4th and 5th grades of two primary schools (one private and one public school) in Milan (Italy) were assessed to form two groups: 18 poor readers (7 girls and 11 boys) and 36 good readers (14 girls and 22 boys), who participated in the experiment. All children were from middle-class families and were monolingual Italian native speakers.

Poor readers had scores of at least 1.5 *SD* above the mean standard score for speed, measured in hundredths of second per syllable, and accuracy, scored as number of errors, on a text reading task (*MT Reading test*, Cornoldi, Colpo, & Gruppo, 1995), in which the child has to read a text passage aloud.

Good readers were matched to poor readers for gender, age, and non-verbal intelligence (*Raven's Coloured Progressive Matrices*). Their scores on the MT reading test were within 0.5 *SD* from the norms for both speed and accuracy (see Table 2).

All the children had normal or corrected-to-normal vision. Informed consent was obtained from parents of children in the study after the nature and the aims of the experiment had been fully explained to them.

Materials

The *Elementary lexicon: Statistical data on written and read Italian language in primary school children* by Marconi, Ott, Pesenti, Ratti and Tavella (1993) was used to extract all the suffixed derived words that could be considered transparent for meaning with respect to their base. The semantic transparency was estimated by empirically rating the derived words for semantic relatedness with their base.[2]

[2] Each derived word was paired with its base word, and a printed list of these word pairs in random order was presented to twenty undergraduate students, who were asked to rate how "related in meaning" the derived word was to the base word in each pair, using a seven-point scale ranging from "Very Unrelated" to "Very Related" (Marslen-Wilson et al., 1994).

Based on the distribution of the ratings, the score of 2.4, corresponding to the lowest quartile of the semantic transparency scale, was identified as the cut-off and only words with mean score >2.4 were considered. From this set only words with bases listed in the *Elementary lexicon* (Marconi et al., 1993), that were phonologically transparent with respect to their bases, had frequent and productive suffixes and stress on the penultimate syllable (the dominant stress pattern in Italian) were selected. Applying these criteria two sets of derived words differing for the grammatical class of the base were obtained: 42 nouns derived from noun bases (e.g., *artista*, artist), and 29 nouns derived from verb bases (e.g., *punizione*, punishment) (see "Appendix").

In addition to base frequency, word frequency, word length, and suffix length were also considered as variables that could affect reading performance.[3] The descriptive statistics of the psycholinguistic features of the stimuli are shown in Table 3. As reported in the table, the two sets of stimuli were matched for mean base frequency, but differed for the mean values of the other variables that may affect reading performance.

In order to avoid inducing a decomposition strategy by presenting derived words only, 99 simple words, comparable to the derived words for length, word frequency, and orthographic endings (e.g., *condizione*, condition) were added to the list of experimental stimuli for a total of 170 stimuli.

Procedure

The stimuli, printed in black lower case (font Courier New 18pt bold) on a white background, were presented in the center of a computer screen. The trial began with a fixation point (300 ms), followed by a brief blank interval (250 ms) and by the stimulus that was displayed until the response was produced. The onset of pronunciation, recorded by a microphone connected to a voice-key, concluded the trial.

The 170 test items were presented in 5 blocks of 34 trials each, separated by an inter-stimulus interval of 1,400 ms. The order of presentation was randomized both within and between blocks. A short pause followed each block. A practice trial of 10 items with the same characteristics as the experimental stimuli was conducted before the first experimental block.

The experiment was run individually in a quiet room at the two schools; the children were asked to read the stimuli aloud as fast and accurately as possible. Reaction times (RTs) were measured in milliseconds (ms) using the E-Prime software. The experimenter recorded naming errors and repairs.

Data analysis

A regression design, allowing for testing the effects of specific variables on reading aloud, and partialling out the effects of other potentially confounding variables, was adopted for the data analysis.

[3] Variables that were shown not to affect reading aloud (e.g., *derivational and compounding family size*; Baayen, Wurm, & Aycock, 2007) were not taken into account.

Table 3 Descriptive statistics of the main psycholinguistic features of the stimuli

	Nouns derived from noun bases (N = 42)				Nouns derived from verb bases (N = 29)				*t*
	Mean	*Min*	*Max*	*SD*	*Mean*	*Min*	*Max*	*SD*	
Word length	8.02	6	11	1.18	9.48	6	12	1.48	−4.62*
Word frequency[a]	13.78	1	69	16.01	37.75	1	126	39.07	−3.57*
Base freq	102.21	4	432	107.76	141.28	2	496	124.50	−1.40
Suffix length	3.64	3	4	0.48	4.52	4	5	0.51	−7.32*

* $p < .001$

[a] Frequency measures are calculated on 1 million occurrences from a corpus of written Italian (Bertinetto et al., 1995)

Voice onset *reaction times* (RTs) were logarithmically transformed in order to obtain a Gaussian-like distribution and were introduced as a dependent variable. Mixed effect regression analyses were employed with participants and items as random effects (Baayen, Davidson, & Bates, 2008).

Word frequency, *word length* in letters, *suffix length* in letters, and *base frequency* (see Table 3) were considered as continuous fixed effects. Word frequency was log-transformed and word length was standardized (see Kuperman et al., 2010) to reduce skewness in the distribution, while a residualization process (Kuperman, Bertram, & Baayen, 2008), in which word frequency was the predictor, was applied to obtain a measure of base frequency partialled out from the frequency effect of the corresponding derived word. The standardized unexplained residuals (rBase Frequency) were then included in the regression analysis in place of base frequency. Similarly, suffix length was included in the analysis as a standardized residual (rSuffix length) predicted by word length, to reduce the high collinearity between word and suffix length.

Group (good vs. poor readers) and grammatical class of the base word (verb vs. noun) were introduced as categorical predictors. Interactions between the predictors were also tested. The analysis started with a full factorial model, which was progressively simplified by removing the variables that did not significantly contribute to the goodness of fit of the model (i.e., the result of the likelihood ratio test comparing the goodness-of-fit of the model before and after removing the effect of each non-significant parameter). Non-significant parameters were excluded one by one, starting from the lesser effects and no parameter that was part of a higher-order interaction was removed from the model. Post-hoc analyses were carried out to improve understanding of the interaction effects. Random slopes of participants and items were also tested, in order to evaluate whether their inclusion significantly increased the goodness-of-fit of the model. The statistical significance of the fixed effects was evaluated using a Markov Chain Monte Carlo (MCMC) sampling (Baayen et al., 2008). Once the models were fitted, atypical outliers were identified and removed (employing 2.5 *SD* of the residual errors as criterion). The models were then refitted to ensure that the results were not driven by a few excessively influential outliers.

Table 4 Mean reaction times and standard deviations (in brackets) and percentages of errors for each group of young readers

	Poor readers	Good readers
Noun derived from N base		
Rt	1,391 (191.71)	762 (84.80)
% Err	7.4 (0.25)	2.3 (0.15)
Noun derived from V base		
Rt	1,527 (266.21)	796 (78.94)
% Err	8.1 (0.27)	3.7 (0.19)

A second analysis with response accuracy as the dependent variable was carried out, using the procedure adopted for RTs. Mixed-effects logistic models were employed (Jaeger, 2008).

Results

Only the trials in which a word was read correctly were analysed (accuracy for good readers: 95 %; for poor readers: 86 %). Technical failures and individual data points deviating from the normal data distribution (evaluated by means of qq-plots) were excluded (good readers: 2 %; poor readers: 7 %). Raw RTs and error percentages for poor and good readers are shown in Table 4.

Latency

Table 5 reports the estimated parameters of the final model[4] for fixed and random effects, together with the significance tests. These parameters are expressed in log(RTs) as the model was fitted using logarithmically transformed RTs. Over and above random intercepts of participants and items, a random slope of participants on suffix length ($SD = 0.0225$) was seen to significantly improve the goodness-of-fit of the model.

Suffix length was the only variable influencing latencies independently: the longer the suffix, the slower the response ($b = 0.0746$, pMCMC $= 0.0001$). All the other factors affected performance in interaction with each other.

The two-way interaction between base category and word length (Fig. 1) indicates that the effect of word length changes depending on the category of the base word. When reading derived words with noun bases, naming latencies increase with word length ($b = 0.0697$; pMCMC $= 0.0008$): the longer the word, the longer the RTs. Conversely, when reading derived words with verb bases, the effect of word length is not significant ($b = 0.0173$; pMCMC $= 0.2844$).

[4] Word initial phoneme, in terms of voicing and place of articulation, was considered as a factorial effect in the initial models. As this variable did not consistently influence naming, probably because of the long RTs observed in the children, it was excluded from the subsequent analyses.

Table 5 Latency: linear mixed-effect regression model parameters and *p* values for fixed effects

Random effect	*SD*
Item: Intercept	0.0722
Participant: Intercept	0.2294
Participant: rSuffix length	0.0225

Fixed effect	Estimate	*MCMC Mean*	*HPD95 Lower*	*HPD95 Upper*	*pMCMC*
Intercept	7.1089	7.1081	7.0078	7.2072	0.0001
Group	−0.4775	−0.4767	−0.5789	−0.3732	0.0001
Base category	0.3098	0.3113	0.1923	0.4356	0.0001
rBase frequency	0.0229	0.0231	−0.0006	0.0487	0.0658
Word frequency	0.0070	0.0070	−0.0126	0.0267	0.4804
rSuffix length	0.0746	0.0747	0.0449	0.1051	0.0001
Word length	0.0326	0.0327	0.0063	0.0589	0.0140
Group × base category	−0.2023	−0.2037	−0.2889	−0.1179	0.0001
Group × rbase frequency	−0.0299	−0.0302	−0.0492	−0.0108	0.0038
Group × word frequency	−0.0076	−0.0076	−0.0220	0.0079	0.3254
Base category × rbase frequency	−0.0619	−0.0623	−0.0996	−0.0234	0.0014
Base category × word frequency	−0.0717	−0.0721	−0.1023	−0.0424	0.0001
Base category × word length	−0.0617	−0.0618	−0.1051	−0.0199	0.0052
Group × base category × rbase frequency	0.0452	0.0455	0.0160	0.0731	0.0020
Group × base category × word frequency	0.0399	0.0402	0.0181	0.0627	0.0002

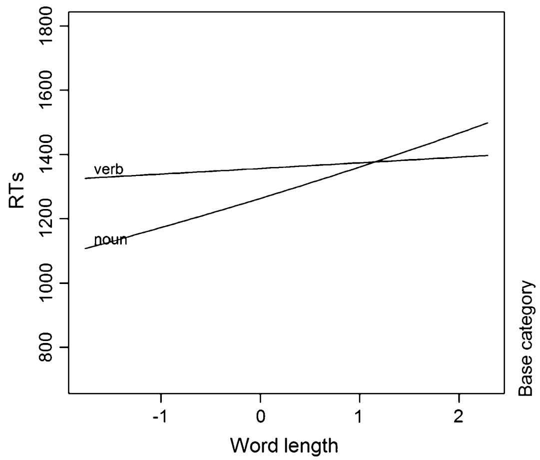

Fig. 1 Interaction of base category and word length

The other results show that reading skill (poor vs. good readers) and base category affect the reading processing of derived words in a complex manner. The three-way interaction between *group*, *base category* and *word frequency* is reported in Fig. 2, showing that in good readers (Fig. 2a) word frequency has a facilitatory effect on latencies, but only when reading derived words with a verb base ($b = -0.0294$; pMCMC = 0.0014); conversely, no significant effect of word frequency was found ($b = 0.0002$; pMCMC = 0.9799) in reading derived words with noun bases. A similar pattern was found in poor readers (Fig. 2b): word frequency had a facilitatory effect in reading deverbal nouns ($b = -0.0587$; pMCMC = 0.0001), but not in reading denominal nouns ($b = 0.0052$; pMCMC = 0.6768). However, when compared with that of good readers, the performance of poor readers showed generally longer latencies and magnified effects (Faust, Balota, Spieler, & Ferraro, 1999).

A similar pattern of results was observed by inspecting the interaction between *group, base category* and *base frequency* (Fig. 3). In good readers (Fig. 3a), base frequency is facilitatory when reading deverbal nouns ($b = -0.0241$; pMCMC = 0.0480), but not for denominal nouns ($b = -0.0096$; pMCMC = 0.4213). In poor readers (Fig. 3b), the

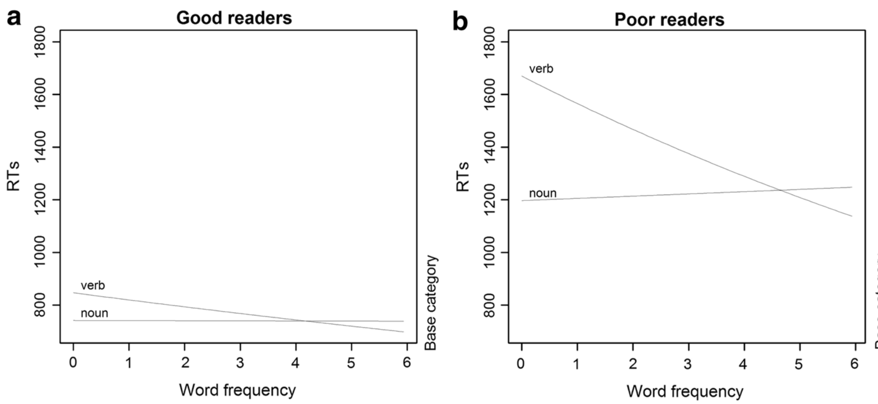

Fig. 2 Interaction between word frequency and base category: **a** in good readers and **b** in poor readers

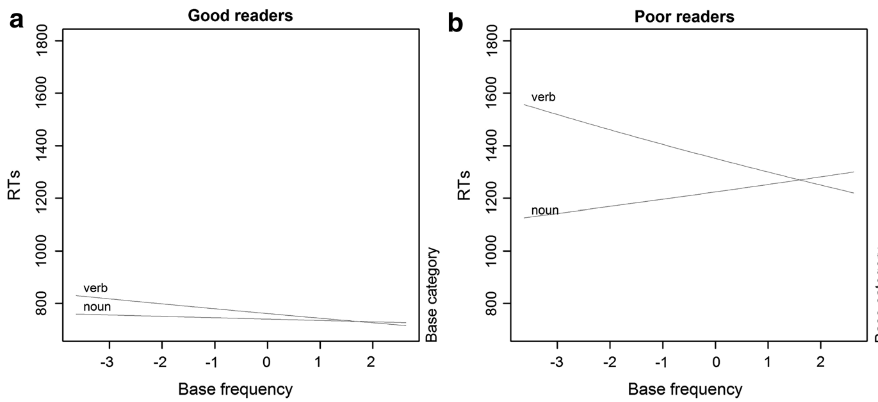

Fig. 3 Interaction between base frequency and base category: **a** in good readers and **b** in poor readers

Table 6 Accuracy: generalized linear mixed-effect regression model parameters and *p* values for fixed effects

Random effect	*SD*			
Item: Intercept	0.7609			
Participant: Inercept	1.0646			
Fixed effect	*Estimate*	*St. error*	*z-value*	*Pr*(>|z|)
Intercept	2.56214	0.40832	6.275	<0.0001
Group	0.98715	0.37165	2.656	0.007904
Base category	−0.65413	0.27882	−2.346	0.018974
rBase frequency	0.23545	0.11311	2.082	0.037377
Word frequency	0.32391	0.09029	3.588	0.000334

facilitatory effect of base frequency approached significance in the case of deverbal nouns ($b = -0.0344$; pMCMC $= 0.0722$), but had no effect on reading denominal nouns ($b = 0.0108$; pMCMC $= 0.5010$).

Accuracy

Table 6 reports the estimated parameters of the final model for fixed and random effects on accuracy. As expected, good readers in general show a higher level of accuracy than poor readers ($b = 0.987$, $z = 2.66$, $p < .001$), but all children are less accurate when reading words derived from a verb base ($b = -0.654$, $z = -2.35$, $p = .02$), although their accuracy increases with increasing word frequency ($b = 0.324$, $z = 3.59$, $p < .001$) and base frequency ($b = 0.234$, $z = 2.08$, $p = .02$), independently of the base word category.

Discussion

The role of morphemic units in language processing has been proved in many experimental conditions since Taft and Forster's (1976) seminal work, but the influence of the grammatical class of the base word has rarely been considered. The present paper focuses on the effect of this variable, as many studies in several languages (e.g., English, Hebrew, Serbo-Croatian, Italian) have revealed differences in processing nouns and verbs not only in healthy adults, but also in patients with acquired language impairments and in children with typical and atypical language development (e.g., Egan & Pring, 2004; Luzzatti et al., 2002; Marshall, 2003). Distributional properties of noun and verb forms have been considered as one of the main features that may generate such differences (Deutsch et al., 1998; Kostić & Katz, 1987; Traficante & Burani, 2003).

The objective of this study was to assess whether the breadth of the inflectional paradigm (inflectional family size) might contribute to the use of the base morpheme as a processing unit when children with different reading skills read a derived suffixed word aloud. The assumption was that base words with a wide inflectional paradigm (i.e., verbs) are more likely to be processed as individual morphemes than base words with a limited inflectional paradigm (i.e., nouns). Consequently, verb bases were expected to induce the reading of derived complex words as a combination of base and affixes. On the contrary, base words with a limited inflectional paradigm (nouns) would be less likely to be accessed as a morphemic unit within a derived word, and so noun bases were not expected to trigger morphological parsing of the words in which they are included. Different procedures for reading aloud nouns derived from verbs and nouns derived from nouns might be particularly evident in readers with poor reading skills, who tend to make extensive use of morphemic units. Previous studies (Burani et al., 2008; Marcolini et al., 2011; Traficante et al., 2011) found that children with dyslexia have less difficulty in reading aloud both words and pseudowords when these can be parsed in base + suffix. In the present study we asked 4th and 5th graders poor and good readers matched by age, gender and non-verbal intelligence, to read aloud nouns derived from verb or noun bases. A mixed-effect linear regression analysis was conducted to estimate the effects of several variables that are likely to affect reading performance.

In the case of derived nouns embedding a verb base, latencies are influenced by both base frequency and word-form frequency. Whereas there is a fair consensus that the base frequency effect is evidence of the activation of the base representation, the interpretation of the word-form frequency effect is still under debate. Traditionally, the latter effect has been considered as evidence of the activation of whole-word representation, but recently Baayen (2010), referring to McDonald and Shillcock's (2001) proposal, criticized this view, suggesting that word frequency may reflect local syntactic co-occurrence of base and affix and does not necessarily imply a whole-word representation in the lexicon. If we apply this interpretation to our results, the word-form frequency effect we found in reading complex words embedding a verb base, taken together with the base frequency effect, could be interpreted as evidence that young readers exploit a verb base as a head start for word naming: the more frequent is the combination of the base with the specific suffix (i.e., the more frequent is the whole-word form), the greater is the gain in using morphemic constituents. In addition, and consistently with the presence of morphemic effects, the surprising absence of the word length effect for deverbal stimuli proves that, even in a language with transparent orthography such as Italian, and also during literacy acquisition, readers make use of reading units (morphemes) at a grain-size that is wider than single letters. Overall, these results extend the hypothesis made for the recognition of inflected forms (see Colombo & Burani, 2002; Laudanna et al., 2002; Traficante & Burani, 2003) to derived forms, i.e., an extensive use of parsing strategies and activation of morphemic units when processing verb forms.

An opposite pattern of results was found for words derived from a noun base. Neither base nor word frequency emerged as significant predictors of naming latencies, but a reliable effect of word length was found. The absence of morphemic effects (i.e., the absence of an effect of base frequency and of the base + suffix combination) in the presence of a whole-word length effect is consistent with the interpretation that children do not activate a morphemic unit (i.e., the noun base) for words derived from a noun (contrary to the case of nouns with a verb base), but tend to use sublexical strategies (i.e., the syllabic and/or letter-by-letter procedure). It can be assumed that the distributional properties of the language, in which word forms with a noun-base are much less numerous than those with a verb base, might not favour the activation of morphemic constituents in the case of words derived from a noun base.

Notwithstanding the above discussed differences between verb and noun bases, the effect of suffix length, which has been proven to be associated with morphemic parsing (Kuperman et al., 2010), was found for both deverbal and denominal nouns. This may suggest that the presence of a long, frequent and productive suffix might trigger morphemic parsing in any case, leading to an overall increasing of latencies for both deverbal and denominal nouns.

The role of morpho-lexical representations was particularly evident in the accuracy data. Consistently with Mann and Singson (2003), Carlisle and Stone (2005), and Deacon et al. (2011), children's reading accuracy on nouns derived from verbs and nouns derived from nouns was influenced by both base and word frequencies: the easier the activation of the base and the word form, the more accurate is the reading performance. The effect of the high number of competing forms belonging to the inflectional family of verbs also emerged in the accuracy data: nouns derived from verbs were read less accurately than nouns derived from nouns. It could be the case that when reading aloud, the advantage of finding a morphemic unit embedded in many different words is counterbalanced by the probability of incorrectly activating a base + suffix combination other than the target.

The pattern of results that was found in the present study supports the view that verbs and nouns are represented differently in the mental lexicon, and the distributional features of the word forms belonging to the two grammatical classes offer a possible explanation of this difference. In fact, the ratio between the occurrence of a specific base + suffix combination and that of any other combination with that same base is much lower for verb bases than for noun bases (approximately 1/50 vs. 1/2). This distributional feature could make morpheme-based reading more likely for words embedding a verb base than for those embedding a noun base, a hypothesis which is supported by the frequency effect found for verb bases. However, in a task involving both input and output processes such as reading aloud, the advantage of finding a morphemic unit embedded in several different words is counterbalanced by the low probability of producing the right base + suffix combination. Therefore, the higher the word frequency in terms of co-occurrence of base and suffix, the lower will be the latencies and the greater will be the degree of accuracy, thus confirming the relevant role of word frequency.

It cannot be excluded that there may be other factors, yet unexplored, which may contribute to the fact that deverbal nouns lead to longer latencies and lower accuracy than denominal nouns. For example, in a model of processing in which it is assumed that the information on grammatical category is represented at lemma level (Levelt, Roelofs, & Meyer, 1999), one can hypothesize that verb-derived nouns activate the verb base and this activation might produce a cross-class interference, that requires time to be resolved. Differently, noun-derived nouns, leading to the activation of a noun base, wouldn't produce such time-costly cross-class interference. Further investigation is needed to test this alternative hypothesis, for example by contrasting noun-derived and verb-derived adjectives.

Another difference between noun and verb bases that might contribute to different probabilities of decomposition lies in the properties of the derivative suffixes that combine with each base type. In their study on lexical decision in English, Ford et al. (2010) observed that affix productivity is typically associated with the consistency of the mapping of a base + affix combination with its underlying meaning. For example, the most productive suffix *-ness* has the function of deriving a noun from an adjective and has only one semantically opaque form (*business*), while the low productive affix *-age* adds to the meaning of the base inconsistently, generating many opaque forms (e.g., *footage*). This study used productive suffixes for both nouns derived from verbs and nouns derived from nouns; however, in Italian the derivational suffixes used to derive a noun from a verb base usually refer to two main meanings only: either the action expressed by the verb (*-ata*, *-mento*, *-tura*, *-zione*; cf. the English suffixes *-ment*, *-tion*) or the agent of the action (*-ore*, *-tore*, *-trice*, *-nte*; cf. the English: *-er*, *-ing*). Hence an Italian reader is likely to find the same verb base in several derived words, combined with different suffixes, in a consistent mapping of form and meaning. On the contrary, most of the derivational suffixes added to noun bases are combined with bases in a form-meaning mapping that is much less consistent than in the case of verb bases: e.g., the suffix *-aio* can express either the person who sells something (e.g., *fioraio*, florist), or a place in which a large quantity of something is present (e.g., *pagliaio*, haystack, *formicaio*, ant-hill). It cannot be excluded that these suffix characteristics contribute to the varying probability of morphemic parsing for deverbal and denominal nouns.

The systematic and transparent form-meaning mapping in the verb base + suffix combination and the distributional properties of verb bases converge to increase the probability that deverbal nouns will be read by means of morphemic units. On the contrary, the lower degree of transparency of the noun base + suffix combinations together with the distributional properties of nouns, may contribute to favouring the storage as whole words of the noun base + suffix combinations, thus making it less likely that denominal nouns will be parsed in morphemes.

The application of sublexical procedures could be a useful auxiliary strategy for reading long, complex words of this type, in particular when reading skills are not completely mastered, as is the case of 4th and 5th graders. At this stage of development, poor readers did not show any specific effect in comparison to good readers: a similar pattern of results was found for both groups and they all seemed prone to using similar reading strategies. So, it can be assumed that, rather than for qualitative differences in processing, the two groups of children vary for some general processing speed factor. This is in line with the Double-deficit hypothesis (Wolf & Bowers, 1999), according to which reading difficulties can be due not only to decoding deficits, but also to a general factor involving processing speed. Consistently, in Italian, a language with transparent orthography in which also children with dyslexia reach a good level of accuracy (in this study poor readers show 86 % of corrected responses), Di Filippo et al. (2005) found that *Rapid Automatized Naming* (Denckla & Rudel, 1976), a measure of speed in retrieving words in naming different types of stimuli, predicted reading skills independently from phonological tasks. This theoretical framework and the evidence on the use of morphemic structure in reading acquisition, proved in the literature and in this work, suggest that the main goal in intervention could be to increase the speed of activation of the morphemic constituents and word representations. This aim might be reached by reinforcing the strategy of finding meaningful chunks inside long words (see Traficante, 2012) and by enriching lexical and morpho-syntactic competence, in order to make early available a high number of lexical representations (Wolf, Miller, & Donnelly, 2000). Elbro & Arnbak (1996) trained morphological awareness in 11 year-old Danish children with dyslexia and did not obtain a large improvement effect on decoding skills, but observed significant effects in reading comprehension and spelling accuracy. Tsesmeli (2009) and Tsesmeli and Seymour (2009) obtained an improved spelling accuracy in both Greek and English students with dyslexia, as a consequence of explicit instructions concerning morphological structure. Results from training studies suggest that different literacy skills can be influenced by the use of morphemic constituents (Goodwin & Ahn, 2013). This pattern of results, along with the data from the present work, confirm the interest of an approach to reading processes, in which morphemic constituents can offer a useful tool to improve reading skills in children with reduced reading speed and impaired reading comprehension (Bowers, Kirby & Deacon, 2010). The gain from the use of morphemic structure could be particularly relevant in reading long low-frequency complex words, such as most of the Italian words that are derived and inflected from verb bases.

In conclusion, the results of the present study, consistently with those of other studies on Italian adults, both healthy (Colombo & Burani, 2002; Laudanna et al., 2002; Traficante & Burani, 2003) and suffering from acquired language disturbances (Marelli, Traficante, Aggujaro, Molteni, & Luzzatti, 2011; Mondini, Luzzatti, Zonca, Pistarini, & Semenza, 2004), suggest that the distributional properties of bases belonging to different grammatical classes affect the reading aloud of derived words and should be taken into consideration when assessing and modelling linguistic competence in the life-span perspective, and in planning educational intervention to increase reading skills.

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Appendix

Stimuli		Word freq	Base freq	Base N-type (fam. size)	Suff freq	Suff N-type (prod)	Word length (letter)	Word length (syll)	Suff length	Cont rules	Double letters	Bigr freq
Nouns derived from noun bases												
aranciata	Orange-juice	2	12	4	1,013	197	9	4	3	1	0	11.82
artista	Artist	55	207	5	1,887	425	7	3	4	0	0	11.69
autista	Driver	25	36	10	1,887	425	7	3	4	0	0	11.26
calzino	Sock	0	11	5	330	209	7	3	3	1	0	11.03
caminetto	Fire-place	5	10	2	287	122	9	4	4	1	1	11.60
campeggio	Campsite	4	328	9	72	19	9	3	5	3	1	11.08
cappotto	Coat	11	4	5	172	35	8	3	4	1	2	11.11
carretto	Handcart	5	26	5	287	122	8	3	4	1	2	11.59
cartello	Poster	17	202	9	171	41	8	3	4	1	1	11.63
cassiere	Cashier	5	75	5	593	102	8	3	4	1	1	11.64
copertina	Cover	25	25	5	355	129	9	4	3	1	0	11.66
fornello	Cooker	4	32	3	171	41	8	3	4	0	1	11.26
fossato	Ditch	1	7	3	1,000	146	7	3	3	0	1	11.36
frontiera	Frontier	20	107	4	149	67	9	3	4	0	0	11.67
lamiera	Sheet	4	15	2	149	67	7	3	4	0	0	11.65
libretto	Booklet	12	335	3	287	122	8	3	4	0	1	11.22
limonata	Lemonade	2	34	2	1,013	197	8	4	3	0	0	11.75
linguaggio	Language	69	96	3	713	77	10	3	5	3	1	10.89
mattinata	Morning	28	74	4	1,013	197	9	4	3	0	1	11.91
mazzata	Blow	4	6	2	1,013	197	7	3	3	0	1	11.13
muretto	Wall	2	114	3	287	122	7	3	4	0	1	11.19
musicista	Musician	20	189	3	1,887	425	9	4	4	1	0	11.18

Appendix continued

Stimuli		Word freq	Base freq	Base N-type (fam. size)	Suff freq	Suff N-type (prod)	Word length (letter)	Word length (syll)	Suff length	Cont rules	Double letters	Bigr freq
occhiata	Glance	40	432	5	1,013	197	8	3	3	2	1	11.35
ondata	Wave	17	57	2	1,013	197	6	3	3	0	0	11.83
orsetto	Bear cub	0	23	2	287	122	7	3	4	0	1	11.47
palazzetto	Building	5	146	1	287	122	10	4	4	0	2	11.08
paniere	Hamper	2	62	4	593	102	7	3	4	0	0	11.77
petroliera	Tanker	1	17	2	149	67	10	4	4	0	0	11.64
poliziotto	Policeman	30	233	2	172	35	10	4	4	0	1	11.34
portiere	Porter	35	251	5	593	102	8	3	4	0	0	11.69
prigioniera	Prisoner	4	27	3	149	67	11	4	4	1	0	11.62
risata	Laughter	18	35	3	1,013	197	6	3	3	0	0	11.76
riviera	Coast	9	39	1	149	67	7	3	4	0	0	11.52
salone	Lounge	38	153	3	155	71	6	3	3	0	0	11.73
scalone	Great staircase	0	72	5	155	71	7	3	3	1	0	11.67
spallata	Shoulder push	2	159	1	1,013	197	8	3	3	0	1	11.70
stilista	Stylist	34	116	2	1,887	425	8	3	4	0	0	11.83
tastiera	Keyboard	5	8	1	149	67	8	3	4	0	0	11.79
tavolino	Table	6	130	4	330	209	8	4	3	0	0	11.61
tendaggio	Curtains	1	28	7	713	77	9	3	5	2	1	11.30
testata	Headboard	8	319	3	1,013	197	7	3	3	0	0	12.00
umorista	Humorist	3	38	1	1,887	425	8	4	4	0	0	11.39
Mean		13.78	102.21	3.64	653.79	154.71	8.02	3.29	3.71	0.50	0.52	11.51
SD		16.04	107.76	2.15	569.80	115.61	1.18	0.46	0.60	0.80	0.63	0.28

Appendix continued

Stimuli		Word freq	Base freq	Base N-type (fam. size)	Suff freq	Suff N-type (prod)	Word length (letter)	Word length (syll)	Suff length	Cont rules	Double letters	Bigr freq
Nouns derived from verb bases												
abitante	Inhabitant	8	102	5	1,113	188	8	4	4	0	0	11.48
assistenza	Assistance	53	100	2	2,134	131	10	4	4	0	1	11.37
cantante	Singer	48	98	9	1,113	188	8	3	4	1	0	12.05
coltivazione	Cultivation	3	33	3	8,553	1,051	12	5	5	1	0	11.43
comandante	Commander	39	24	6	1,113	188	10	4	4	1	0	11.77
commerciante	Merchant	14	2	3	1,113	188	12	4	4	2	1	11.50
consumazione	Consumption	1	67	1	8,553	1,051	12	5	5	1	0	11.29
costruzione	Construction	66	202	3	8,553	1,051	11	4	5	1	0	11.20
creazione	Creation	36	240	4	8,553	1,051	9	4	5	1	0	11.17
credenza	Belief	7	496	3	2,134	131	8	3	4	1	0	11.07
esistenza	Existence	87	306	3	2,134	131	9	4	4	0	0	11.47
fallimento	Washout	33	40	3	1,450	45	10	4	5	0	1	11.71
ferimento	Wounding	3	43	5	1,450	45	9	4	5	0	0	11.70
formazione	Formation	89	141	8	8,553	1,051	10	4	5	1	0	11.25
mancanza	Lack	67	253	2	640	59	8	3	4	1	0	11.32
negazione	Negation	5	85	2	8,553	1,051	9	4	5	0	0	11.29
operazione	Operation	126	80	5	8,553	1,051	10	5	5	0	0	11.58
partenza	Departure	67	252	3	2,134	131	8	3	4	0	0	11.27
pendenza	Slope	4	10	5	2,134	131	8	3	4	0	0	11.41
privazione	Deprivation	2	18	3	8,553	1,051	10	4	5	0	0	11.43
produzione	Production	111	179	4	8,553	1,051	10	4	5	0	0	10.91
proibizione	Prohibition	2	14	2	8,553	1,051	11	4	5	0	0	10.99

Appendix continued

Stimuli		Word freq	Base freq	Base N-type (fam. size)	Suff freq	Suff N-type (prod)	Word length (letter)	Word length (syll)	Suff length	Cont rules	Double letters	Bigr freq
punizione	Punishment	20	30	2	8,553	1,051	9	4	5	0	0	11.28
speranza	Hope	117	194	7	640	59	8	3	4	0	0	11.39
tendenza	Tendency	54	77	7	2,134	131	8	3	4	0	0	11.48
tentazione	Temptation	25	195	3	8,553	1,051	10	4	5	0	0	11.78
trafficante	Dealer	2	120	2	1,113	188	11	4	4	1	1	11.27
trattazione	Treatment	1	378	2	8,553	1,051	11	4	5	0	1	11.72
usanza	Habit	6	319	4	640	59	6	3	4	0	0	10.86
Mean		37.75	141.28	3.83	4,633.93	539.86	9.48	3.83	4.52	0.41	0.17	11.39
SD		39.07	124.50	2.00	3,621.87	470.63	1.48	0.60	0.51	0.57	0.38	0.27

Word freq = word frequency out of 1 million occurrences; Base freq = base frequency out of 1 million occurrences; Base N-type (fam. size) = number of different word-types that contain the base (family size); Suff freq = suffix frequency out of 1 million occurrences; Suff N-type (prod) = number of different word-types that contain the suffix (suffix productivity); Word length (letters) = word length in letters; Word length (syllables) = word length in syllables; Suff length = suffix length in letters; Cont rules = number of *c, g,* and *sc* letters, that need the following letter context to assign the correct pronunciation (Barca, Ellis, & Burani, 2007); Double lett = number of double letters; Bigr freq = word's mean bigram frequency, log transformed (natural logarithm)

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