Disponible on-line en:
http://revistalogopedia.uclm.es
Revista de investigación en Logopedia 2 (2012) 163-185.
ISSN-2174-5218

From graphemes to morphemes: An alternative way to improve skills in children with dyslexia

Daniela Traficante

Catholic University of Milan, Italy

Resumen

En este trabajo se presenta una revisión de los datos y modelos más importantes sobre lectura que pueden guiar la intervención en el caso de los niños con dificultades en ella. En particular el artículo se centra en la evidencia sobre el papel de los constituyentes morfológicos en el reconocimiento de palabras y en la lectura en voz alta. Los datos de niños con y sin dislexia muestran la utilidad de la segmentación morfológica para mejorar la fluidez y la comprensión lectora. Los resultados que se presentan son interpretados a la luz de la propuesta de Grainger & Ziegler's (2011). El marco que ofrecen estos autores sobre procesamiento lector puede ser considerado como muy interesante dado que ofrece una visión integradora de la adquisición lectora en la cual la conciencia morfológica puede desempeñar un papel importante junto con los componentes fonológicos y fonológicos. En este trabajo se presentan también algunos ejemplos de intervenciones destinadas a mejorar el uso de los constituyentes morfológicos de los niños con dificultades lectoras.

Palabras clave: Adquisición de la lectura; Modelos de lectura; .Morfología.

Abstract

This contribute provides a review of the main research data and models that can guide training interventions in the case of reading difficulties. In particular, the paper is focused on evidence concerning the role of morphemic constituents in word recognition and reading aloud. Data from children with and without dyslexia show the usefulness of morphemic parsing to improve fluency and comprehension. The results are interpreted in the light of Grainger & Ziegler's (2011) proposal. It can be considered an interesting framework to model reading processes, as it offers an integrate view of reading acquisition, in which even morphological awareness can play an important role along with orthographic and phonological components. Some examples of training interventions aimed at improving the use of morphemic constituents in children with reading difficulties are presented and discussed.

Key words: Morphology; Reading acquisition; Reading models.

Correspondence with author daniela.traficante@unicatt.it.

Received 1 November 2012. Accepted 20 November 2012.

Introduction

Learning to read: is it a matter of grain size?

Learning to read is a complex task that involves several functions beyond visual and phonological processing, i.e. the allocation of attention, eye movements, spatial and temporal processing, memory, semantic associations, but also affective and motivational components, which influence the engagement in the task. With practice, most of the functions involved in the decoding process are automatized and children get free cognitive resources to deeply elaborate the content of the text they are reading.

The time required to reach a good rate of accuracy and fluency in reading aloud varies according to the consistency in grapheme-to-phoneme mappings of the language that has to be read. Spanish, Italian, German and Greek children show a more rapid reading acquisition than children reading deep orthographies, as shown, for example, by studies comparing Spanish with Portuguese children (Defior, Martos, & Cary, 2002) and Spanish with French and English children (Goswami, Gombert, & de Barrera, 1998). Seymour, Aro, and Erskine (2003), comparing English with 12 other European languages, found that, by the end of the first grade, Greek children can read 90% of familiar words correctly, while Scottish English-reading children showed only 34% accuracy. Based on this evidence, Ziegler and Goswami (2005) suggested the grain size theory, according to which the readers of shallow orthographies can rely on small grain-size units, hence they can acquire a decoding strategy that leads to high levels of accuracy quite soon.

However, even though the grapheme-to-phoneme conversion can help in reaching a good rate of accuracy in early reading acquisition, there is strong evidence that skilled readers, even in shallow orthographies, activate whole-word representations to speed up reading and have fast access to the meaning. A relevant corpus of data from Italian language shows both lexical (e.g., frequency and stress assignment effect) and sublexical (e.g., length effect) effects in reading aloud in Italian adults and children with and without dyslexia (Barca, Burani, Di Filippo, & Zoccolotti, 2006; Barca, Ellis, & Burani, 2007; Paizi, Zoccolotti, & Burani, 2011), and similar data have been found by Davies, Rodríguez-Ferreiro, Suárez, and Cuetos (2012) in Spanish children. These results are consistent with Share's Self-Teaching Hypothesis (1995, 2008), which suggests that repeated identification of a word through pre-lexical phonological processing leads to the elaboration of the corresponding orthographic representation.

So, the orthographic lexicon would develop as a consequence of sublexical grapheme-to-phoneme processing, and that is the reason why even in shallow orthographies, lexical effects can be found from the early stage of reading acquisition (Zoccolotti, De Luca, Di Filippo, Judica, & Martelli, 2009).

An intermediate, meaningful grain size: The role of morphemic constituents

A wide corpus of data has shown that in front of long and complex words (e.g., *development*), a relevant contribution to the activation of lexical representations comes from the identification of morphemic constituents (e.g., *develop-*, *-ment*). In fact, many studies have shown that morphological awareness is related to word reading. Mann and Singson (2003) found that in the first year of school, word reading is predicted by phonological awareness, but the reading ability of fifth-grade students is better predicted by morphological than by phonological skills. Other studies showed that poor readers have difficulty in reading opaque words (Carlisle, Stone, & Katz, 2001; Windsor, 2000), but benefit from the morphemic structure of transparent words (Carlisle, 2000). Carlisle and Stone (2005) found that both lower elementary readers (grades 2 and 3) and upper elementary students (grades 5 and 6) were more accurate in reading derived words with a transparent structure, but only the lower-grade students were faster too. They also showed that middle and high school students read phonologically transparent derived words more accurately, but only the younger read the transparent words more rapidly as well. The effect of morphological awareness on learning to read has also been suggested by Casalis and Louis-Alexandre (2000), who observed, in French, a clear effect of this competence in grades 1 and 2. Jarmulowicz, Hay, Taran, and Ethington (2008) proposed a developmental model of reading, grounded on a path analysis carried out on data from third-grade students. They assessed the effect of receptive language, phonological, morphological and morpho-phonological awareness and decoding skills (reading non-sense words aloud) on reading comprehension. Data showed that only receptive language and decoding have significant direct effects on reading comprehension, but morpho-phonological and phonological awareness had significant effects on decoding, and morphological skills affected morpho-phonological awareness.

The attitude to using the morphemic structure of a word has been observed in different languages, varying by orthographic depth and morphological richness (see, e.g., Verhoeven & Perfetti, 2011). Morphemic parsing is influenced by the relative frequency of the whole word and of the base, and by the productivity of the affixes, both in a shallow orthography such as Italian (Marcolini, Traficante, Zoccolotti, & Burani, 2011) and Spanish (Lázaro, 2012) and in a deep orthography such as English (Deacon, Whalen, & Kirby, 2011).

This pattern of results suggests that during literacy acquisition, in order to optimize the fluency, the accuracy and the comprehension of the text, children not only learn to use grapheme-to-phoneme associations, but also to detect chunks of letters, such as morphemes. These units can be extracted from the language input as consistent associations among sounds, orthographic patterns and meanings. So, for example, the words “desirable”, “undesirable”, “desirably”, “undesirably”, “desiring”, “desired”, etc., share the same base “desire” plus prefix (e.g., “un-”) and suffixes (“-able”, “-ably”, “-ing”, “-ed”), and their meanings can be easily extracted from the combination of the meanings of the base and the affixes, even though the whole words can be rather unfamiliar.

Morphemes can be particularly useful in the early phases of reading acquisition, to identify patterns of letters that are very consistent among several words. They are units larger than single graphemes, and can be read faster than the corresponding string of letters, as they allow the time-consuming grapheme-to-phoneme procedure to be avoided. Their role can also be very crucial in favoring lexicon enrichment and reading comprehension. In front of new words, the opportunity to identify familiar morphemes can help children in understanding the meaning without explicit instructions. Evidence of this role comes from studies on the processing of pseudo words in Italian (Burani, Marcolini, De Luca, & Zoccolotti, 2008; Traficante, Marcolini, Zoccolotti, & Burani, 2011), and French (Quémart, Casalis, & Duncan, 2012).

The question of the independence of the morphology effect from phonology awareness in learning to read has been raised by Mann (2000), who underlined that morphemic units are grounded on phoneme- and syllable-size units. This question is mostly relevant in studying dyslexia. On the one hand, according to the view considering phonology as the area in which the core deficit of dyslexia can be identified, one can expect that the phonological deficiencies of children with dyslexia do not allow them to reach morphology awareness. On the other hand, evidence from the above-mentioned experimental data seems to demonstrate that they can improve their fluency and accuracy by using morphemic units. Casalis, Colé, and Sopo (2004), comparing children with dyslexia and reading age controls, found that phonological impairments would prevent the explicit segmentation of affixes, leading to lower scores in morphological tasks. However, children with dyslexia were more fluent than younger controls in producing words sharing the same target base. This result suggests that children with dyslexia may benefit from oral as well as written language input in order to develop morphological skills. Given their phonological difficulties, they are more likely to activate semantic information than to rely on phonological information, but they are able to use morphological processing to build up compensatory strategies in reading.

What kind of information drives morphemic parsing in reading?

To test the mechanisms involved in processing morphologically complex words, the masked priming paradigm in a lexical decision task has usually been adopted both in adults (Longtin, Segui, & Hallé, 2003; Rastle, Davis, Marslen-Wilson, & Tyler, 2000) and in children (Beyersmann, Castles, & Coltheart, 2012; Casalis, Dusautoir, Colé, and Ducrot, 2009; Quémart, Casalis, & Colé, 2011; Schiff, Raveh, & Fighel, 2012). This paradigm comprises a sequence of events that starts with the presentation of a forward mask (500 ms), then goes on with the presentation of a briefly (about 40-70 ms) presented stimulus (the prime), followed by the target stimulus, on which the participant is asked to produce his/her response about the lexicality of the item. Rastle, Davis, and New (2004), from data with adults, proposed that morphemic parsing is carried out on the basis of orthographically defined chunks of letters, corresponding to morphemes, regardless of any semantic relationship between base and affixes. The so-called corner-CORN effect refers to the fact that the presence of a base and an affix (gold + -en; corn + -er) is sufficient to trigger morphemic parsing. In other words, any morpho-orthographic surface structure can produce priming. These data led the authors to conclude that in skilled adult readers morphological decomposition is semantically blind. From that seminal work a lot of experimental studies followed (see Davis & Rastle, 2010; Diependaele, Sandra, & Grainger, 2009; Feldman, O'Connor, & Moscoso del Prado Martin, 2009; Rastle & Davis, 2008) and a rather inconsistent framework emerged, which has been interpreted in three different models of morphemic processing. According to the so-called *Form-then-meaning* approach (Rastle & Davis, 2008), the first stage of morphemic parsing is the mapping of the letter string in morpho-orthographic representations, while semantic analysis is carried out later in the process. The *Supralexical decomposition* account (Giraudo & Grainger, 2003) underlines the role of semantic components and postulates that morphemic units are only recognized through a morpho-semantic decomposition. Finally, hybrid models (*Parallel dual-route accounts*: Diependaele et al., 2009; Feldman et al., 2009) predict that morpho-orthographic and morpho-semantic decomposition occur simultaneously.

Recently, Duñabeitia, Kinoshita, Carreiras, and Norris (2011) used a cross-case masked priming same-different task and found, in Spanish, data supporting the view that morpho-orthographic segmentation is not an obligatory component of orthographic processing, but a device that can be applied only when the activation of lexical representations is required, such as in a lexical decision task. This supports multiple-route models, in which morpho-orthographic segmentation is one of the available mechanisms for lexical access, but is not a compulsory fast pre-lexical step in the orthographic processing system.

As for children, Casalis et al. (2009) found, in French fourth-graders, a priming effect for morphologically (e.g., *laveur-LAVAGE*) and orthographically (e.g., *lavande-LAVAGE*) related pairs when the early phase of processing is tapped (prime duration: 75 ms), while at long prime duration (250 ms) only morphemic condition gives rise to priming effects. Authors interpreted the data as evidence that both orthographic and morphological information are used, in different phases of processing. Beyersmann et al. (2012) pointed out that in Casalis et al.'s (2009) experiment there was no pseudosuffixed condition, corresponding to the corner-CORN pair. In their work they presented Australian, English-speaking third- and fifth-graders with morphologically (e.g., golden-GOLD), pseudomorphologically (e.g., mother-MOTH) related pairs and control condition. With 50 ms prime exposure they obtained a priming effect only with the truly suffixed condition. Based on these data, the authors suggested that children learn to use the morphemic structure of complex words after having understood the meanings of related entities that characterize sets of whole words sharing the same root. In other words, after a number of word representations sharing the same root have been acquired, children will understand the links between morphemic constituents and the corresponding meanings, and they become able to use this competence in reading complex words.

Quémart et al. (2011) presented French third-, fifth- and seventh-graders with a masked primed paradigm, using three different SOA for prime (60 ms, 250 ms, 800 ms). They found that morphological relationship produced priming effect whatever the prime duration, while the priming from pseudoderivation condition was similar to the morphological one at 60 ms, but lower than that condition at 250 ms prime exposure. At 800 ms the pseudoderivation priming effect disappeared, showing that with long prime duration the activation of semantic properties of morphemes is required to trigger morphemic parsing.

The pattern of results from English and French children is not very consistent and further experiments are needed to understand the role of form and meaning in morphemic parsing during reading acquisition. In particular, a relevant variable could be the orthography system of the language: shallow orthographies could lead to a more evident morpho-orthographic effect, due to the orthographical and phonological transparency of the morphemic structure in most complex words, while deep orthographies would require a higher involvement of semantic components. In Italian, Traficante, Marelli, and Crepaldi (2012), using 54 ms prime duration, in third to fifth grades, found a priming effect only for the morphological relationship (e.g., *farinoso-FARINA*, mealy-meal), but not for pseudoderivation (e.g., *violenza-VIOLA*, violence-violet) and orthographic condition (e.g. *costume-COSTO*, costume-cost). Data are consistent with the hypothesis that in the course of reading acquisition, form-meaning mapping is crucial to detect morphemic units.

In order to better organize the complex pattern of data supporting the role of morphemic structure in learning to read, and to find clues for making up reliable and effective rehabilitative interventions, referring to models of reading acquisition can be very helpful.

Modelling reading acquisition: from graphemes to morphemes

The Dual-Route Cascaded Model (*DRC*: Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001), based on clinical data from adults with acquired dyslexia, has given us a useful framework to share data and hypotheses on written text processing, to produce a diagnostic taxonomy and to imagine which process the child we are observing is likely to activate during his performance, in particular whether he/she is using the visual-lexical route or the grapheme-to-phoneme correspondence rules (Figure 1).

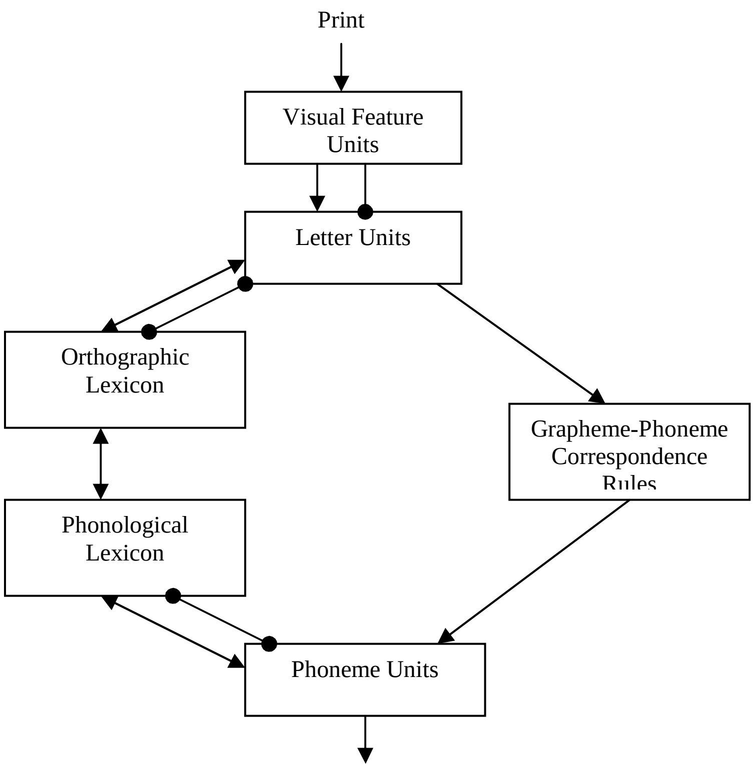

Figure 1 – Dual-Route Cascaded Model (from Coltheart et al., 2001)

A competing way of representing reading processes comes from the connectionist approach, which produced the so-called *Triangle Model* (Seidenberg & McClelland, 1989) (Figure 2) and several other one-route models (Plaut, McClelland, Seidenberg, & Patterson, 1996). Usually in these models there is no distinction between lexical and sublexical routes, but reading is explained in terms of associations among semantic, phonological and orthographic representations, learned by the system during repeated exposure to the oral and written language.

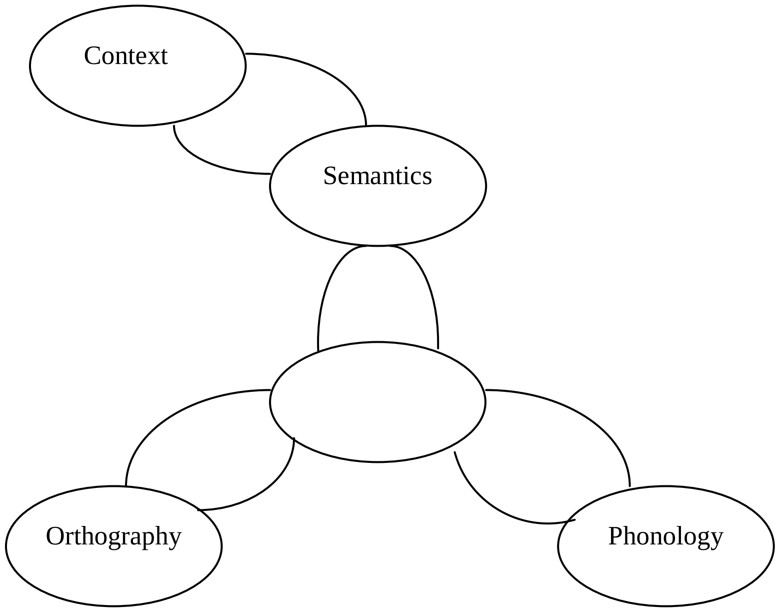

Figure 2 – Triangular model (from Seidenberg & McClelland, 1989)

Both models, the *DRC* and *Triangle model*, have been implemented on English monosyllabic words, but several efforts have been made to also take into account morphological effects. So, on the one hand, Rastle and Coltheart (2000) proposed a DRC model useful for processing disyllabic words. In this framework, an automatic pre-lexical mechanism is proposed, aimed at isolating suffixes on the base of orthographic patterns. The morphemic units activated in the first stage are orthographic chunks (e.g., -ing, -ed, -er, etc.), which are automatically activated as soon as the correspondent letters are detected in the stimulus. Data from Rastle, Davis, and New's (2004) experiments support this model and suggest that the presence of morpho-orthographic units is a sufficient condition for morphemic parsing to be triggered (see corner-CORN effect) (but for a different point of view, see Duñabeitia et al., 2011). On the other hand, the Triangle model does not consider specific representations for morphemic units, but proposes that morphemic awareness emerges as a complex pattern of associations between orthographic, phonetic and semantic representations. According to this approach, morphemic units bear with them meaning information and can speed up the reading process leading to faster activation of associated orthographic, phonetic and semantic representations.

A new model, which is worth considering, has been proposed by Grainger and Ziegler (2011). The authors describe a dual-route approach to orthographic processing that postulates the existence of two fundamentally different kinds of sublexical, orthographic codes. This distinction has a particular relevance for the aim of considering the role of morphology in reading acquisition, as it allows a developmental perspective to be assumed that can offer interesting cues to make up rehabilitative intervention.

The authors start from the BIAM model (Bimodal Interactive-Activation Model; Diependaele, Ziegler, & Grainger, 2010; Grainger & Ferrand, 1994; Grainger & Ziegler, 2008; Jacobs, Rey, Ziegler, & Grainger, 1998), which describes the silent reading process. It presents two routes from orthography to semantics, i.e., a direct route via orthographic units and an indirect route via phonology (Figure 3). This approach may well account for the rapid involvement of phonological codes in the process of silent word reading (Braun, Hutzler, Ziegler, Dambacher, & Jacobs, 2009; Diependaele et al., 2010; Grainger & Ziegler, 2008), but has been further developed to better simulate how a skilled reader, given a letter string, in a very short time (about 250 ms per word), can uptake information from the stimulus and make out the semantic information needed for comprehension.

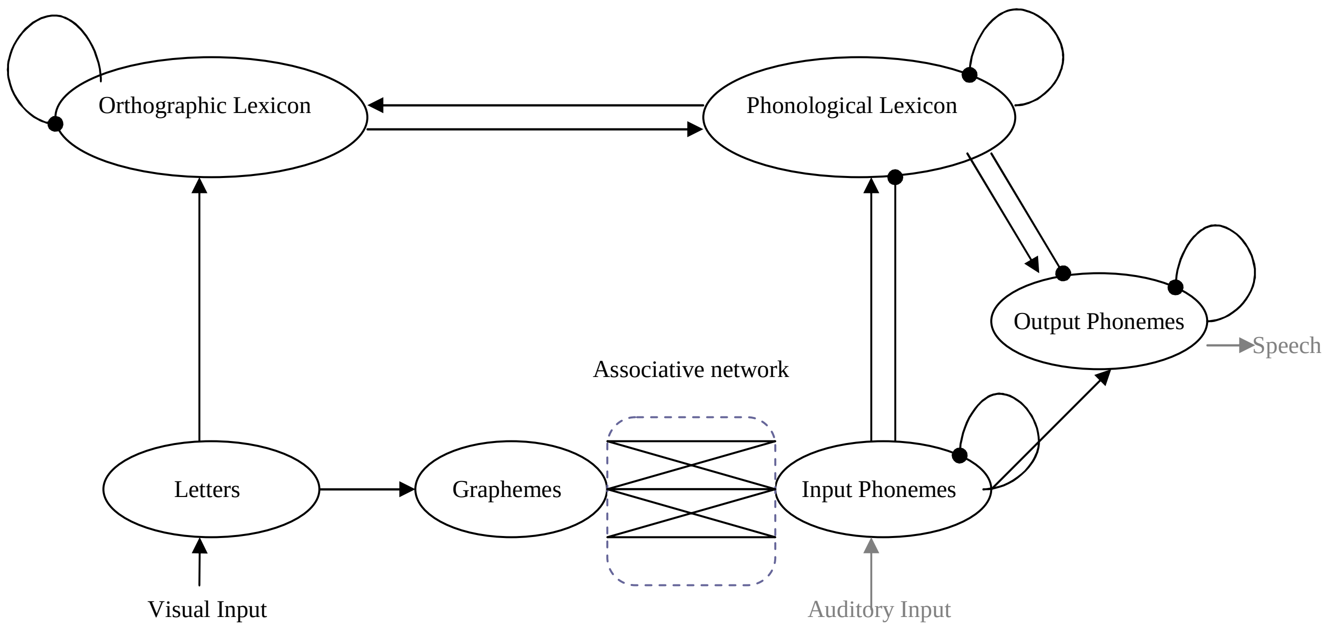

Figure 3 – The Bimodal Interactive-Activation Model (BIAM) (from Diependaele et al. 2010)

In particular, Grainger and Ziegler (2011) tried to better specify the processing of the orthographic information. They assumed that, to speed up the process, two kinds of route are activated in parallel. On the one hand, the system uptakes the information about the presence of letter combinations, without precise positional information (*coarse-grained orthography*) to reach target identification as soon as possible, at a glance (*diagnosticity*). Letter combinations with low frequency of co-occurrence are more diagnostic of the identity of the word, so, for example, in front of the letters *y-a*, *y-c*, *y-h*, *y-t*, etc., it is quite easy to identify the word *yacht*. On the other hand, when there are letters that co-occur very often in the language (e.g., multi-letter graphemes, affixes), they can be grouped (*chunking*) to form higher-level orthographic representations (*fine-grained orthography*), coding precise information about the ordering of letters in the string. This mechanism leads to an improvement in the process, through the reduction of units to be activated (Figure 4). Both the routes send activation to a whole-word level, in which only the representation corresponding to the visual input enables the associated meaning to be activated.

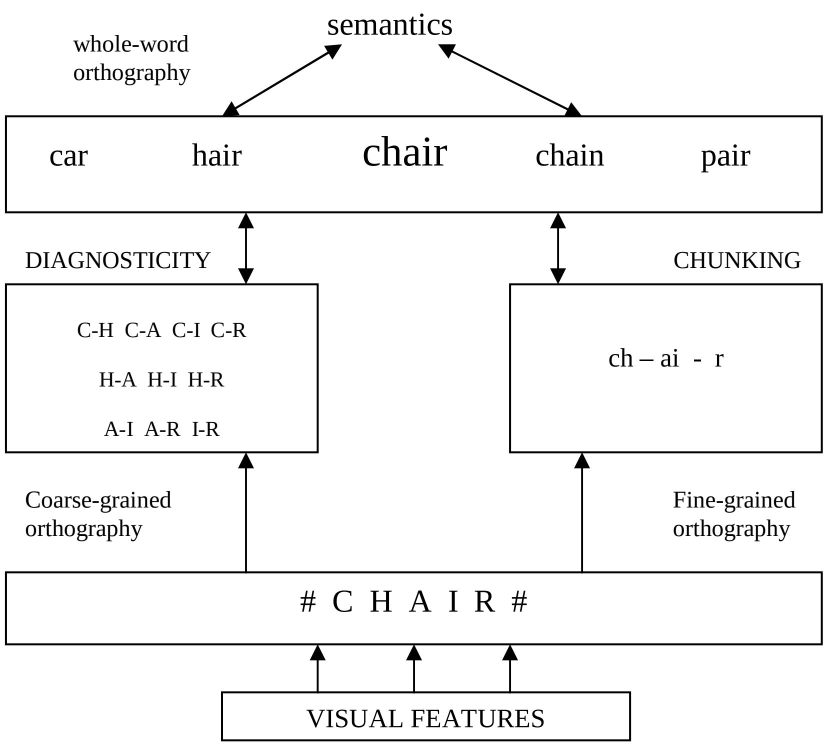

Figure 4 – Grainger & Ziegler's (2011) dual-route approach to orthographic processing

In this model, morphological awareness (*morpho-semantics level*) is represented in the organization of the whole-word representations, which emerges from the experience of the overlapping of several words in form and meaning. Morpho-semantic representations provide bidirectional connectivity among whole-word representations belonging to the same morphological family. This specific connectivity plays a central role in processing complex words. In front of this kind of target, through the fine-grained orthography route, sublexical morpho-orthographic segmentation of the string leads to the activation of the stem and the affixes. These representations send activation to the whole-word level and, thanks to the special interconnectivity among words sharing form and meaning, the activation of the target is enabled.

The integration of the two orthographic pathways with the phonological route of the BIAM produces a multiple-route model of word comprehension in silent reading, in which only the fine-grained representations interface with sublexical phonological representations. This complex model can be useful for understanding how children learn to read.

Grainger and Ziegler (2011) start from the observation that the beginning reader has two sources of information available, i.e., the knowledge of the alphabet and the spoken vocabulary. So, his/her main task is to associate letter identities with sounds that resemble whole-word phonological representations of known words (Figure 5). In the first phase (Step 1), orthographic input is processed letter by letter, as letters and letter combinations are phonologically recoded. According to Share (1995), each successful decoding can provide the beginning reader with the opportunity to create connections between the word form and the meaning. Through the repeated exposure to printed words and the laborious serial procedure of the phonological recoding, a parallel letter processing develops. Children begin to codify letter strings through location-specific letter detectors (Step 2), which gradually leads to the two types of orthographic codes described in the model (coarse-grained and fine-grained) (Step 3).

To improve reading acquisition, a useful strategy is to optimize the mapping from letters to meaning through the activation of pathways already used to map speech onto meaning during spoken language comprehension. A way to develop the fine-grained processing route, i.e. the route providing access to semantics via phonological and morphological representations, is to help the children in detecting frequently co-occurring letter combinations, favoring chunking. These representations are particularly relevant for detecting suffixes or rhymes, for which the coding of letter position is crucial.

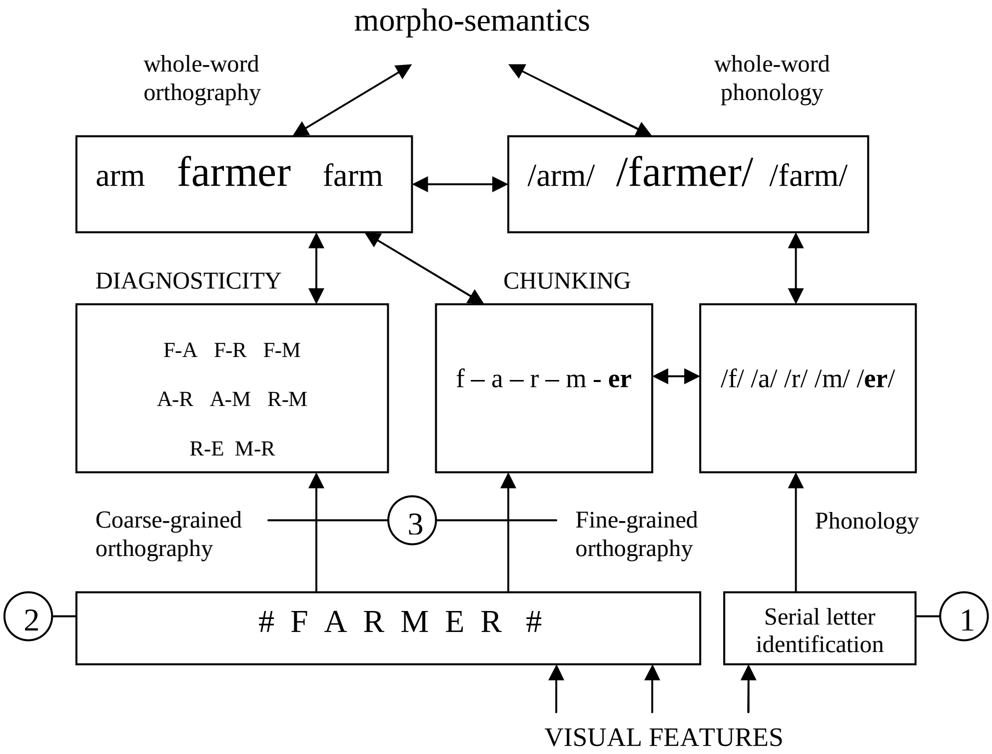

Figure 5 - Steps of reading acquisition: phonemic, orthographic and morphemic components in a multiple-route model of silent reading (adapted from Grainger & Ziegler, 2011).

During the learning of fine- and coarse-grained representations, attention function has been found to be a critical factor in learning dependencies among elements (e.g., Le Pelley, 2010; Pacton & Perruchet, 2008). In learning to read, usually external supervision leads children to focus attention on contiguous elements, teaching them that a given complex grapheme corresponds to a particular phoneme. In this way, a child can learn that a contiguous sequence of letters corresponds to pre-existing phonological and/or morphological representations, acquired in spoken language.

If the description of reading acquisition made by Grainger and Ziegler (2011) has a good fitness to the real process, then one could wonder whether it is possible, for an external teacher, to improve the learning of the fine-grained orthography mechanism and improve reading ability in poor readers and in children with dyslexia.

Is teaching morphemic parsing useful?

According to the developmental description of Grainger and Ziegler's (2011) model, it has been assumed that in early phases children learn to encode graphemes and other sublexical units into the corresponding phonemes, which address the whole-word representations and activate the associated meanings. So, it can be assumed that, at least for beginning readers, phonological awareness, i.e., the ability to analyze and blend phonemes, plays a central role in reading acquisition.

In English literature, in which the assumption that a lack of phonological skills is the core deficit of developmental dyslexia (see, for example, Boada & Pennington, 2006; Snowling, 2000), there is a lot of intervention aimed at improving phonological awareness (see, for example, Torgesen et al., 2001). This kind of training, however, has effects on accuracy and comprehension, but not on reading speed. In shallow orthography languages (such as Spanish, Italian, German, Dutch and Finnish), due to the consistency in grapheme-to-phoneme correspondence, dyslexia is not associated with low accuracy, but with slow reading speed. To improve this component, three different approaches have been applied: a) reading repetition, which asks children to read the same words and texts several times; b) limited exposure duration (LED), to force the use of sight reading of more letters; c) use of sublexical units (digrams, syllables, morphemes).

Marinus, de Jong, and van der Leij (2012) noted that the first technique leads to improvement only in reading trained materials (Chard, Vaughn, & Tyler, 2002), while the LED technique applied by van den Bosch, van Bon, and Schreuder (1995) also shows some effects on untrained words. In light of the latter results, however, it is unclear whether the improvement in reading speed is a consequence of the application of more efficient reading strategies or an increased use of letter clusters.

Different trainings have been applied to enhance the use of letter clusters, but the transfer effect to untrained clusters or to new words embedding trained clusters is small. To interpret this failure, Marinus et al. (2012) observed that this kind of training has mostly used implicit methods to teach the use of letter clusters, focusing particularly on the visual aspect of the clusters. So the authors made up an intervention in which they proposed an explicit training on the links of the blended sounds to the letter cluster and on the use of these clusters in word recognition. They trained about 60 second-grade poor readers with two different methods, a cluster training (trained clusters: st-, gr-, bl-, tr-) and a letter training (trained letters: s, t, g, r, b, l). They managed to improve reading speed in trained clusters and letters, but did not obtain the generalization of the effect in untrained clusters and words. Marinus et al. (2012) concluded that their results, along with data from other training studies in German and Dutch (Hintikka, Landerl, Aro, Lyytinen, 2008; Marinus & de Jong, 2008; Thaler, Ebner, Wimmer, & Landerl, 2004; van Daal, Reitsma, van der Leij, 1994), suggest that the acquisition of letter clusters is not a causal mechanism behind the development of word reading speed in transparent orthographies. They hypothesize that wider grain-size units can give better outcomes, as studies with syllables in Italian (Tressoldi, Vio, & Iozzino, 2007), Dutch (Wentink, Van Bon, & Schreuder, 1997), French (Ecalle, Magnan, & Calmus, 2009) and Finnish (Huemer, Aro, Landerl, & Lyytienen, 2010), and the study with morphemes in Danish (Elbro & Arnbak, 1996) seem to suggest.

It is worth noting, however, that the training of syllable decoding generally has different outcomes than the training of morphemes, as syllable training may increase accuracy and reading speed, while morpheme training leads to improvement in reading comprehension and spelling. Elbro & Arnbak (1996), who published a study based on morphological training, presented children with dyslexia (mean age = 11 years) with activities proposed by class teachers aimed at increasing morphological awareness. They proposed oral exercises on compounding, derivation and inflection and assessed children’s abilities in several tasks before and after 36 training sessions lasting 15 minutes each. Results showed that it is possible to train morphological awareness in children with dyslexia, but this improvement did not automatically produce a large effect on decoding skills. Only reading comprehension and spelling gained quite a lot. As for text comprehension, it seems that the experimental group learned to make better use of their decoding skills (whatever they are), focusing on the morphemic structure to make out the meaning. As for the unexpected improvement in spelling, the authors propose that in this activity, differently from reading, there is the time to activate linguistic knowledge and so to recognize and apply the morphemic structure properties to correctly write down complex words. Moreover, the meaningfulness of morphological segments can make it easier to hold them in the working memory while spelling, leading to a higher rate of accuracy. While the morphological structure of the word is available to the speller, according to Elbro and Arnbak (1996), it is not fully available to the reader, who has to decode from left to right strings of letters that he/she cannot identify as morphemic units until the whole word is recognized. In other words, the reader can recognize the prefix *re-* in *reappear* only after reading the whole word, while the same sequence of letters *re* is not a prefix in the word *regular*.[1]

The promising results on spelling were replicated by Tsesmeli and Seymour (2009) in English. The authors found that, in adolescents with dyslexia, morphographic training improved spelling not only of trained-derived words, but also of untrained structurally analogous words, and this result was long-term persistent.

Conclusions

The wide corpus of data on the role of morphology in literacy acquisition suggests that improving morphological awareness and teaching morphemic strategies may be a useful way to help children with dyslexia to compensate for their difficulties in decoding written language. In particular, outcomes of training studies show that focusing on the morphemic structure of words may lead to better text comprehension and more accurate spelling.

Even though experimental data on the mechanisms involved in morphemic parsing are controversial, reading models derived from them can offer an interesting framework to understand observed behavioral data and to drive assessment and training of reading difficulties. They can allow us to consider not only the weak, but also the strong points of the reading attitude of the child we are observing. In a multiple-route approach, we are more likely to find the route(s) leading to the goal: reading to understand, to know, to enjoy.

References

Barca, L., Burani, C., Di Filippo, G., & Zoccolotti, P. (2006). Italian developmental dyslexic and proficient readers: where are the differences? *Brain and Language, 98,* 347-351.

Barca, L., Ellis, A. W., & Burani, C. (2007). Context-sensitive rules and word naming in Italian children. *Reading and Writing: An Interdisciplinary Journal*, *20,* 495-509.

Beyersmann, E., Castles, A., & Coltheart, M. (2012). Morphological processing during visual word recognition in developing readers: Evidence from masked priming. *The Quarterly Journal of Experimental Psychology*, *65*, 1306-1326.

[1] This suggestion is in line with the hypothesis of supralexical representation of morphology (Giraudo & Grainger, 2001).

Boada, R., & Pennington, B. (2006). Deficient implicit phonological representations in children with dyslexia. *Journal of Experimental Child Psychology*, *95,* 153-193.

Braun, M., Hutzler, F., Ziegler, J. C., Dambacher, M., & Jacobs, A. M. (2009). Pseudohomophone effects provide evidence of early lexico-phonological processing in visual word recognition. *Human Brain Mapping*, *30*, 1977–1989.

Burani, C., Marcolini, S., De Luca, M., & Zoccolotti, P. (2008). Morpheme-based reading aloud: Evidence from dyslexic and skilled Italian readers. *Cognition*, *108*, 243-262.

Burani, C., Marcolini, S., & Stella, G. (2002). How early does morpho-lexical reading develop in readers of a shallow orthography? *Brain and Language, 81,* 568-586.

Carlisle, J.F. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing: An Interdisciplinary Journal*, *12*, 169-190.

Carlisle, J. F., & Stone, C. A. (2005). Exploring the role of morphemes in word reading. *Reading Research Quarterly, 40,* 428-449.

Carlisle, J.F., Stone C.A., & Katz, L.A. (2001). The effects of phonological transparency on reading derived words. *Annals of Dyslexia*, *51*, 249-274.

Casalis, S., Colé P., & Sopo, D. (2004). Morphological awareness in developmental dyslexia. *Annals of Dyslexia*, *54,* 114-138.

Casalis, S., Dusautoir, M., Colé, P., & Ducrot, S. (2009). Morphological effects in children word reading: A priming study in fourth graders. *British Journal of Developmental Psychology*, *27,* 761-766.

Casalis, S., & Louis-Alexandre, M. F. (2000). Morphological analysis, phonological analysis and learning to read French: A longitudinal study. *Reading and Writing: An Interdisciplinary Journal*, *12*, 303-335.

Chard, D. J., Vaughn, S., & Tyler, B. J. (2002). A synthesis of research on effective interventions for building reading fluency with elementary students with learning disabilities. *Journal of Learning Disabilities*, *35,* 386–406.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: a dual route cascaded model of visual word recognition and reading aloud. *Psychological Review, 108*, 204-256.

Davies, R., Rodríguez-Ferreiro, J., Suárez, P., & Cuetos, F. (2012). Lexical and sub-lexical effects on accuracy, reaction time and response duration: Impaired and typical word and pseudoword reading in a transparent orthography. *Reading and Writing: An Interdisciplinary Journal*. DOI 10.1007/s11145-012-9388-1.

Davis, M.H., & Rastle, K. (2010). Form and meaning in early morphological processing: Comment on Feldman, O'Connor, and Moscoso del Prado Martin (2009). *Psychonomic Bulletin and Review*, *17*, 749-755.

Deacon, S.H., Whalen, R., & Kirby, J.R. (2011). Do children see the *danger* in *dangerous*? Grade 4, 6, and 8 children's reading of morphologically complex words. *Applied Psycholinguistics*, *32*, 467-481.

Defior, S., Martos, F., & Cary, L. (2002). Differences in reading acquisition development in two shallow orthographies: Portuguese and Spanish. *Applied Psycholinguistics*, *23*, 135-148.

Diependaele, K., Sandra, D., & Grainger, J. (2009). Semantic transparency and masked morphological priming: The case of prefixed words. *Memory and Cognition, 37,* 895-908.

Diependaele, K., Ziegler, J.C., & Grainger, J. (2010). Fast phonology and the bimodal interactive activation model. *European Journal of Cognitive Psychology, 22*, 764-778.

Duñabeitia, J.A., Kinoshita, S., Carreiras, M., & Norris, D. (2011). Is morpho-orthographic decomposition purely orthographic? Evidence from masked priming in the same-different task. *Language and Cognitive Processes*, *26,* 509-529.

Ecalle, J., Magnan, A., & Calmus, C. (2009). Lasting effects on literacy skills with a computer-assisted learning using syllabic units in low-progress readers. *Computers & Education*, *52*, 554-561.

Elbro, C., & Arnbak, E. (1996). The role of morpheme recognition and morphological awareness in dyslexia. *Annals of Dyslexia*, *46*, 209-240.

Feldman, L. B., O'Connor, P. A., & Moscoso del Prado, F. (2009). Early morphological processing is morpho-semantic and not simply morpho-orthographic: A violation of form-then-meaning accounts of lexical recognition. *Psychonomic Bulletin & Review*, *16*, 684-691.

Giraudo, H, & Grainger, J. (2003). A supralexical model for French derivational morphology. In E. M. H. Assink and D. Sandra (Eds.), *Reading complex words: Cross-language studies*, (pp. 139-157). New York: Kluwer Academic.

Goswami, U., Gombert, J. E., & Barrera, L. F. (1998). Children's orthographic representations and linguistic transparency: Nonsense word reading in English, French and Spanish. *Applied Psycholinguistics*, *19*, 19- 52.

Grainger, J., & Ziegler, J.C. (2011). A dual-route approach to orthographic processing. *Frontiers in Psychology*, doi: 10.3389/fpsyg.2011.00054.

Grainger, J., & Ferrand, L. (1994). Phonology and orthography in visual word recognition: Effects of masked homophone primes. *Journal of Memory and Language*, *33*, 218–233.

Grainger, J., & Ziegler, J. (2008). Cross-code consistency effects in visual word recognition. In E. L. Grigorenko and A. Naples (Eds.), *Single-Word Reading: Biological and Behavioral Perspectives*, (pp. 129–157). Mahwah, NJ: Lawrence Erlbaum Associates.

Hintikka, S., Landerl, K., Aro, M., Lyytinen, H. (2008). Training reading fluency: Is it important to practice reading aloud and is generalization possible? *Annals of Dyslexia*, 58, 59-79.

Huemer, S., Aro, M., Landerl, K., & Lyytinen, H. (2010). Repeated reading of syllables among Finnish-speaking children with poor reading skills. *Scientific Studies of Reading*, *14*, 317-340.

Jacobs, A. M., Rey, A., Ziegler, J. C., & Grainger, J. (1998). MROM-P: An interactive activation, multiple read-out model of orthographic and phonological processes in visual word recognition. In J. Grainger and A. M. Jacobs (Eds.), *Localist Connectionist Approaches to Human Cognition*, (pp. 147–188) Mahwah, NJ: Lawrence Erlbaum Associates.

Jarmulowicz, L., Hay, S. E., Taran, V. L., & Ethington, C. A. (2008). Fitting English derived word production into a developmental model of reading. *Reading and Writing: An Interdisciplinary Journal*, *21*, 275-297.

Lázaro, M. (2012). The effects of base frequency and affix productivity in Spanish. *The Spanish Journal of Psychology*, *15*, 505-512.

Le Pelley, M. E. (2010). Attention and human associative learning. In C. J. Mitchell and M. E. Le Pelley (Eds.), *Associative Learning: From Brain to Behaviour*, (pp. 187-216). Oxford: Oxford University Press.

Longtin, C. M., Segui, J., & Hallé, P. A. (2003). Morphological priming without morphological relationship. *Cognitive Processes*, *18*, 313–334.

Mann, V. A. (2000). Introduction to special issue on morphology and the acquisition of alphabetic writing systems. *Reading and Writing: An Interdisciplinary Journal*, *12*, 143-147.

Mann, V. A., & Singson, M. (2003). Linking morphological knowledge to English decoding ability: large effects of little suffixes. In E.M.H. Assink & D. Sandra (Eds.), *Reading complex words: Cross-language studies*. (pp. 1-25). New York: Kluwer Academic.

Marcolini, S., Traficante, D., Zoccolotti, P., & Burani, C. (2011). Word frequency modulates morpheme-based reading in poor and skilled Italian readers. *Applied Psycholinguistics*, *32*, 513-532.

Marinus, E., de Jong, P.F., & van der Leij, A. (2012). Increasing word-reading speed in poor readers: No additional benefits of explicit letter-cluster training. *Scientific Studies of Reading*, *16*, 166-185.

Marinus, E., & de Jong, P.F. (2008). The use of sublexical clusters in normal and dyslexics readers. *Scientific Studies of Reading*, *12*, 253-280.

Pacton, S., & Perruchet, P. (2008). An attention-based associative account of adjacent and nonadjacent dependency learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*, 80-96.

Paizi, D., Zoccolotti P., & Burani C. (2011). Lexical stress assignment in Italian developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal*, *24*, 443 - 461.

Plaut, D.C., McClelland, J.L., Seidenberg, M.S., & Patterson, K.E. (1996). Understanding normal and impaired word reading: Computational principles in quasi-regular domains. *Psychological Review*, *103*, 56-115.

Quémart, P., Casalis, S., & Colé, P. (2011). The role of form and meaning in the processing of written morphology: A priming study in French developing readers. *Journal of Experimental Child Psychology*, *109*, 478-496.

Quémart, P., Casalis, S., & Duncan, L.G. (2012). Exploring the role of bases and suffixes when reading familiar and unfamiliar words: Evidence from French young readers. *Scientific Studies of Reading*, *16*, 424-442.

Rastle, K., & Coltheart, M. (2000). Lexical and nonlexical print-to-sound translation of dysillabic words and nonwords. *Journal of Memory and Language*, *42*, 342-364.

Rastle, K., & Davis, M. H. (2008). Morphological decomposition based on the analysis of orthography. *Language and Cognitive Processes*, *23*, 942–971.

Rastle, K., Davis, M. H., & New, B. (2004). The broth in my brother's brothel: Morpho-orthographic segmentation in visual word recognition. *Psychonomic Bulletin & Review*, *11*, 1090–1098.

Rastle, K., Davis, M. H., Marslen-Wilson, W. D., & Tyler, L. K. (2000). Morphological and semantic effects in visual word recognition: A time-course study. *Language and Cognitive Processes*, *15*, 507–537.

Schiff, R., Raveh, M., & Fighel, A. (2012). The development of the Hebrew mental lexicon: When morphological representations become devoid of their meaning. *Scientific Studies of Reading*, *16*, 383-403.

Seidenberg, M.S., & McClelland, J.L. (1989). A distributed, developmental model of word recognition and naming. *Psychological Review*, *96*, 523-568.

Seymour, P.H.K., Aro, M., & Erskine, J.M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, *94*, 143-174.

Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, *55*, 151–218.

Share, D.L. (2008). Orthographic learning, phonological recoding, and self-teaching. In R. Kail (Ed.), *Advances in child development and behaviour*. (pp. 31-82). San Diego: Academic Press.

Snowling, M.J. (2000). *Dyslexia* (2nd edition). Oxford: Blackwell.

Thaler, V., Ebner, E. M., Wimmer, H., & Landerl, K. (2004). Training reading fluency in dysfluent readers with high reading accuracy: Word specific effects but low transfer to untrained words. *Annals of Dyslexia*, *54*, 89–113.

Torgesen, J.K., Alexander, A.W., Wagner, R.K., Rashotte, C.A., Woeller, K., Conway, T. & Rose, E. (2001). Intensive remedial instruction for children with severe reading disabilities: Immediate and long-term outcomes from two instructional approaches. *Journal of Learning Disabilities*, *34*, 33-58.

Traficante, D., Marcolini, S., Luci, A., Zoccolotti. P., & Burani C. (2011). How do roots and suffixes influence reading of pseudowords: A study of young Italian readers with and without dyslexia, *Language and Cognitive Processes*, *26*, 777-793.

Traficante, D., Marelli, M., & Crepaldi, D. (2012). How shallow is morphemic parsing in a shallow orthography? A study with Italian children. *Cognition and Language: Research conference in memory of Patrizia Tabossi*, Trieste, November 9.

Tressoldi, P.E., Vio C., & Iozzino, R. (2007). Efficacy of an intervention to improve fluency in children with developmental dyslexia in a regular orthography. *Journal of Learning Disabilities*, *40*, 3, 203-209.

Tsesmeli, S.N., & Seymour, P.H. (2009). The effects of training of morphological structure on spelling derived words by dyslexic adolescents. *British Journal of Psychology*, *100*, 565-592.

Van Daal, V.H.P., Reitsma, P., & van der Leij, A. (1994). Processing units in word reading by disabled readers. *Journal of Experimental Child Psychology*, *57*, 180-201.

Van den Bosch, K., van Bon, W.H.J., & Schreuder, R. (1995). Poor readers' decoding skills: Effects of training with limited exposure duration. *Reading Research Quarterly*, *30*, 110-125.

Verhoeven, L., & Perfetti, C. A. (2011). Introduction to the special issue Morphological processing in reading acquisition: A cross-linguistic perspective. *Applied Psycholinguistics*, *32*, 457-466.

Wentink, H.W.M.J., Van Bon, W.H.J., & Schreuder, R. (1997). Training of poor readers' phonological decoding skills: Evidence for syllable-bound processing. *Reading and Writing: An Interdisciplinary Journal*, *9*, 163-192.

Windsor, J. (2000). The role of phonological opacity in reading achievement. *Journal of Speech, Language, and Hearing Research*, *43*, 50-61.

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*, *131*, 3–29.

Zoccolotti, P., De Luca, M., Di Filippo, G., Judica, A., Martelli, M. (2009). Reading development in an orthographically regular language: effects of length, frequency, lexicality and global processing ability. *Reading and Writing: An Interdisciplinary Journal, 22*, 1053-1079.